

BUSINESS RESPONSE TO NATURAL DISASTER:
A CASE STUDY OF THE RESPONSE BY FIRMS IN
GREENVILLE, NORTH CAROLINA TO HURRICANE FLOYD

By

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To the people of eastern North Carolina,
who have weathered many storms, and persevered in the face of adversity.

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This research attempts to fill a gap in the area of natural hazards and economic geography fields. It examines business response to disaster by analyzing data from 41 surveys and 28 interviews. The study area was an industrial district immediately north of the Tar River, where it passes through Greenville, North Carolina. This area was chosen because of the extensive flooding that was reported there after Hurricane Floyd struck the state in September, 1999. The participants were limited to those firms that do not market to individuals or households. The bulk of participants were manufacturers, wholesalers, and transportation and warehouse operators. Employment levels at the participating establishments ranged from fewer than ten to over 1000. Limited response to some questions reduced the number of variables available for analysis. Nonetheless, results of this research indicate that the immediate disruptive impacts to firms after Hurricane

Floyd included impassable roads and the limited availability of management and staff. Furthermore, setbacks of longer duration occurred if buildings, inventory, or equipment were extensively damaged. In addition, the interviews demonstrated that the sophistication of the firm's disaster-response strategy is linked to the levels of management at the firm. Those firms with more levels of management tended to develop more elaborate disaster-response strategies. These often included complex activities to assist displaced employees with their survival issues.

CHAPTER I INTRODUCTION

Hurricane Floyd persisted as an organized storm from September 7 to September 17, 1999. It consolidated into a tropical storm while located roughly 750 nautical miles east of the Leeward Islands. By the time it reached the eastern Bahamas on September 12, Floyd had strengthened to almost a Category 5 hurricane that extended 600 miles (965 km) in diameter (BBC 1999; Pasch, Kimberlain & Stewart 2001). Floyd's path led it somewhat to the east of the Bahamas, Florida, Georgia, and South Carolina. Floyd lost strength as he moved northward along the southeastern coast of the U.S. By the time he made landfall on September 16, near Wilmington, North Carolina, he was a Category 2 hurricane.

Floyd dredged a path across eastern North Carolina throughout the day, before crossing into the Tidewater area of Virginia (near Norfolk). A weakened but faster-moving Floyd continued up the Atlantic seaboard, and again made landfall (near New York City) only hours after his arrival in North Carolina (Pasch, Kimberlain & Stewart 2001). From this point, Floyd tracked inland through Connecticut, Massachusetts, and New Hampshire, all the while veering back toward the Atlantic coast. The remnants of Floyd continued on along the entire coastline of Maine and New Brunswick, Canada. Floyd finally ran out of steam on September 17, after crossing Newfoundland, Canada (FEMA 2000b; Pasch, Kimberlain & Stewart 2001).

Because of his extensive path, Floyd had the potential to inflict catastrophic damages to the entire eastern seaboard of North America. As it stands at present, Floyd caused the largest evacuation in the history of the United States (Wilson *et al.* 1999). He also created some of the most serious flooding seen along the east coast of the United States in the twentieth century (FEMA 2000a, 2000b, 2000c). In fact, while Floyd's official death toll is 78, 51 of those fatalities occurred in North Carolina. Consequently, Floyd is the state's deadliest storm of the twentieth century (Elliott 2000, NCDC 2000, Zagier 2000). North Carolina was the state most severely hit by Floyd. Sixty-six of the state's 100 counties were declared major disaster areas by President Clinton. Several of these counties received more than 20 inches of rain. An assessment conducted by the Federal Emergency Management Agency (FEMA 2000b) grouped those 66 counties into the following impact categories:

- Major damage: 14 counties
- Moderate damage: 16 counties
- Minor damage: 14 counties
- Negligible damage: 22 counties

The counties that suffered the most damage are those situated in eastern North Carolina; they are located along the coast, or within the Neuse River Basin, the Tar River Basin, or the Cape Fear River Basin (Bales, Oblinger & Salenger 2000; FEMA 2000b). Unlike the damage sustained from Hurricane Andrew in 1992, which was predominantly due to high winds and tornadic activity (FEMA 1993), much of the damage from Hurricane Floyd was due to flooding (FEMA 2000b). Not surprisingly, those counties that did not implement hazard reduction measures before Floyd's arrival suffered greater damages from the storm (FEMA 2000b).

Typically floods are considered to be a slow-onset disaster of potentially long duration. While the residents in North Carolina were given advance notice of Hurricane Floyd's approach (Pasch, Kimberlain & Stewart 2001), their preparations were not adequate to cope with the catastrophic flooding across eastern North Carolina. Indeed, communities in North Carolina that were previously believed to be outside the floodplain were inundated (FEMA 2000b, Zagier 2000). Others suffered flooding that was considered to be equivalent to a 100-year or 500-year event (Bales, Oblinger & Sallenger 2000; Zagier 2000).

Perversely enough, sometimes it not the size that matters, but the timing. Floyd was a Category 2 hurricane on the Saffir-Simpson scale when it struck North Carolina (Pasch, Kimberlain & Stewart 2001). Such storms are noted for their flooding of low-lying escape routes, considerable damage to mobile homes, and generally modest structural damage to small residences and utility buildings (NHC 2001b). However, Floyd arrived only a few weeks after Hurricane Dennis dumped substantial rains on the Carolinas. Ironically, before these storms came ashore the state was suffering from a mild drought. Because many of the businesses in the most heavily damaged counties were either small businesses, or those dependent on clear roads (retail, services) or public perception (tourism, fisheries), their economic losses were greater than would be expected from simple structural damage estimates (FEMA 2000b, Wilson *et al.* 1999). The close pass of yet another hurricane (Irene) only weeks after Floyd served to prolong the difficulties of recovery.

Generally speaking, the state of North Carolina was enjoying an economic upswing in 1999, despite the impact of Hurricanes Dennis, Floyd and Irene. However,

much of this growth was occurring far from the coastal areas of the state. In fact, eastern North Carolina has traditionally lagged behind the rest of the state in terms of economic performance. The percentage of population living in poverty in these counties exceeds the state's average, and the per capita income is more than 20% lower than the national average. The main agricultural activities (tobacco farming and processing) have been declining for several years (FEMA 2000b, Wilson *et al.* 1999). Yet farmers are diversifying their activities in response to changes within the tobacco industry. Across the eastern region of the state farmers are including large-scale, commercial production of hogs, chickens, or turkeys in their operations (Hart & Chestang 1996).

Manufacturing within the eastern region is also changing. Many employers are switching to more automated processing techniques, thereby reducing their need for labor (FEMA 2000b, Wilson *et al.* 1999). Yet in Greenville, North Carolina, some manufacturers have been expanding their facilities. Labor needs are further increases as new manufacturers established factories (PCDC 1999). But industry transitions are influenced by factors beyond the control of the state. Changes in the global marketplace affect industrial output. Likewise, setbacks caused by catastrophic flooding also affect business output. Estimates of the losses suffered by businesses across eastern North Carolina are summarized in Table 1.

While these numbers are staggering, there are other, less obvious impacts suffered by businesses. These include setbacks caused by damaged infrastructure elements. One example is problems suffered because of impassable roads. Roads are rendered impassable when flooded, or when the roadbed becomes oversaturated with water. This results in breaks or holes appearing in the road's surface. Unfortunately, these dangerous

breakages in the roadway may not appear until vehicles begin to place strain on the pavement. Damages to bridges can render a road impassable as well.

Table 1—Hurricane Floyd's Estimated Toll on Eastern North Carolina's Business

Commercial Businesses	Outcome
Number of businesses affected	60,000
Percentage of firms having 1 or more displaced employees	21%
Percentage of businesses that reduced their labor force	10%
Percentage of planned business expansions that were cancelled	29%
Percentage of businesses that shut down for more than 3 days	75%
Value of structural damage	\$1 billion
Value of lost revenue	\$4 billion
Percentage of firms that donated money or goods to relief efforts	66%
Agricultural Businesses	Outcome
Number of farms damaged	30,000
Value of forestry losses	\$89 million
Value of farm structure damage	\$256 million
Value of agricultural property losses	\$800 million
Value of crop damage	\$543 million
Value of livestock damage	\$13 million
Number of livestock & pets killed	2.9 million*

Sources: FEMA 2000b, Stephenson 2000, Wilson *et al.* 1999, and Zagier 2000

* Note: this includes 2.1 million chickens, 750,000 turkeys, and 30,500 hogs

In addition, problems with water treatment facilities can create a variety of difficulties for businesses. For instance, restaurants are not permitted to operate if wastewater treatment is unavailable. On the other hand, discharge of untreated sewage into floodwaters contaminates all surfaces (such as drywall) exposed to the floodwater. A fourth problem is the increased water volume brought about by dam failures. An affiliated problem is the prolonged loss of a source of potable water until the dam is repaired. Finally, for businesses that support small towns or crossroad communities, flooding of the community can force away the residents who are workers or customers of these firms. A summary of Hurricane Floyd's toll on eastern North Carolina's infrastructure is presented below (Table 2).

Table 2—Hurricane Floyd's Toll on Eastern North Carolina's Infrastructure

Number of roads damaged or impassable*	>1000
Number of bridges damaged, destroyed or impassable	15
Number of dams damaged, failed, or overflowed	176
Number of public wastewater treatment facilities damaged, failed, or overtopped	23
Number of communities with submerged downtown areas	30

Sources: FEMA 2000b, McComas 2000, Stephenson 2000, Wilson *et al.* 1999

* Note: includes parts of Interstates 95 & 40, US Highways 64, 70 & 264

This research uses the city of Greenville as a case study to examine how firms were affected by, and responded to, the damage caused by Hurricane Floyd. This is accomplished through five research questions. The first examines the relationship between a firm's experience with hurricanes and the level of damage sustained from Hurricane Floyd. Second is the affect of the flood's damage to various business elements (such as production, inventory, and transportation systems) on the firm's operations. Third is the degree to which a firm's attributes (e.g., size, site ownership, operation type) influence its disaster response. The fourth evaluates the role of business networks in affecting a firm's disaster response. Last is the evaluation of what tasks a disaster-impacted firm considers most important for restoring normal operations. This study is exploratory in nature, since no previous research of this type has been conducted.

This research is presented in the 10 following chapters. The first two discuss the academic literature that influences the structure of this study: Natural Hazards in Theory and Practice, and Business Considerations. Next is the Methodology chapter, which lays out the actual procedures used in gathering and analyzing the data for this research. Chapters 5, 6, and 7 present background information on topographic features of the state (The Lay of the Land in North Carolina), meteorological history of the storms of 1999 (Hurricane Alley), and changes in the human environment within the eastern region of

the state that influenced the severity of the flooding in 1999 (People of Eastern North Carolina). These are followed by three chapters of results: Comparative Analysis of the Survey Responses (Chapter 8), Interview Results (Chapter 9), and Quantitative Results (Chapter 10). The final chapter (11) presents the conclusions of this research, and recommendations for future research.

CHAPTER 2

NATURAL HAZARDS IN THEORY AND PRACTICE

Natural hazards and social systems are inseparably linked. As a general rule, people evaluate and describe hazards in terms of the hazard's potential to harm humans or human society. The measure of risk varies with the cultural and economic attributes of those people who are in some degree of jeopardy due to the likelihood of a natural hazard event actually occurring. This chapter discusses the attributes of a natural hazard event. It is broken down into two main sections: what defines a natural disaster, and who are the actors after a natural disaster. The definitions section is further broken down into two subsections; they discuss the various means used by natural scientists and social scientists to describe a natural hazard event.

What Defines a Natural Disaster?

One might expect that defining a natural disaster would be reasonably straightforward. However, potentially destructive events caused by natural hazards are technically not considered to be disasters unless their impact to human society surpasses some tolerance threshold. For instance, some volcanoes (such as Mt. Etna, in Sicily) erupt every few years, and with limited destructive force. These natural hazard events are not considered to be disasters unless the toll to humans or their property becomes excessive (Smith 1996). Therefore, disasters are described based on their impact to humans, and this description varies with the perceptions, culture, and affluence of the people involved (Blaikie *et al.* 1994; Burton, Kates, & White 1993; Oliver-Smith &

Hoffman 1999). Generally speaking, academic experts within the natural sciences describe natural disasters as a geophysical process, whereas experts within the social sciences describe disasters as a social event. Examples of each are presented below.

Natural Disaster as a Geophysical Process

In order to use a process to create a classification system, experts in the natural sciences rely on one of three sets of features: the event's intrinsic attributes, its causal attributes, or its outcome (Smith 1996). These sets of features contribute to the human ability to adapt and respond to the risk present in their natural environment. For example, hardened structures can be built to channel the lava flows and lahars associated with volcanoes that erupt frequently, but not violently. These structures serve as an adaptive strategy that allows human settlement to live with less anxiety concerning the natural hazard associated with their community (Smith 1996). The *intrinsic attributes* of a natural disaster are those traits that are part of the event's *process*. According to Burton, Kates & White (1993), there are six intrinsic attributes of a natural hazard:

- Frequency
- Temporal spacing
- Speed of onset
- Duration
- Areal extent, and
- Spatial dispersion.

The frequency, or regularity of occurrence, differs from temporal spacing in that a city might suffer a catastrophic earthquake very infrequently (in human terms)—perhaps once every few hundred years. In the aftermath of such a devastating earthquake, however, the community could suffer scores of aftershocks. While the first few aftershocks may occur in close frequency during the first few days after the event itself, the remaining tremors

may occur over the space of weeks. Therefore the temporal spacing of the aftershocks changes with the passage of time. The speed of onset may be quick, as seen with earthquakes, or slow—like droughts. Likewise the duration may be short (earthquakes) or long (droughts). Neither the speed of onset nor the duration of the event, however, is an indicator of the intensity of the event. Therefore, the destructive power of an event may be greater in a short but intense, than in a long yet mild event. The final pair of contrasting intrinsic attributes are the areal extent of a natural disaster and its spatial dispersion. Areal extent refers to how widespread the disaster's impacts were felt; in other words, the area destroyed. Spatial dispersion refers to the "distance covered," or the degree of diffusion of the event over the landscape. For example, a tornado has a very limited areal extent (the narrow width of its contact area) when compared with other natural hazards. Yet a tornado's spatial dispersion (the path of its destruction) can cover miles.

Interestingly, the disastrous flooding of 1999 falls within the gray area between the pairs of attributes. Hurricanes are not a sudden onset event, although there may not be much advance warning. Floods, likewise, are neither sudden nor slow in their onset. However, the severity of Floyd's impacts were caused by the temporal spacing, duration, areal extent, and spatial dispersion of the hurricanes of 1999. (This is presented in detail in Chapter 6). Had not four significant rain events occurred in less than two months, the flooding that resulted would not have been so severe. Likewise, had the rainfall of the storms not deluged most of the eastern third of the state, the region's devastation might have been lessened.

On the other hand, defining hazardous natural events based on their *causal attributes* generally segregates events into two categories: geophysical or biological. For example, geophysical hazards are those meteorological or geological/geomorphic natural hazard events that occur as part of a series of processes in nature, such as blizzards, hailstorms, volcanic eruptions, tsunamis, or even erosion (Burton, Kates & White 1993). Biological hazards can be occurrences of either disease or infestation. Disease hazards include malaria, bubonic plague, and hoof and mouth disease. Floral and faunal infestations include red tide, water hyacinth, rats, termites, and locusts. Schneider (1980) developed an intriguing variation to this method of defining hazards according to causal geophysical processes. In Schneider's system, the *originating geophysical source* of the hazardous process is the basis for the classification. Therefore, hurricanes and floods are defined as atmospheric hazards, tsunamis are hydrospheric, and earthquakes can be mantle-based or lithospheric hazards.

Using the attributes of the *outcome* of a hazard event, Tobin & Montz (1995) developed a slightly different schema. Outcome-based definitions would result in a hurricane being defined as a compound atmospheric hazard, and a flood as a hydrologic hazard. This is because a hurricane is the outcome of multiple meteorological processes occurring sequentially and simultaneously. In the same vein, a flood may be caused by a hurricane or other meteorological events, but it is ultimately the outcome of changes to the hydrologic environment.

A drawback to many of these classification systems is that they leave out the human element in natural hazards. Natural hazards are part of the greater natural cycle. Yet they are also inextricably linked to human social systems. Thus, when hazards

jeopardize the way of life of humans, these events are referred to as a disaster. The next section briefly presents the descriptions applied to natural disasters by social scientists.

Natural Disaster as a Social Event

As a general rule, disasters are those events that jeopardize the livelihood and well-being of a human population due to an event that disrupts the normalcy of existence. Although the insurance industry defines a monetary threshold which distinguishes a “disaster” from a “catastrophe” (NRC 1999), there is no widely used standard for defining an event as a disaster. However, the more disruptive the event, the greater the disaster experienced by the population. On the other hand, the easier it is for the population to absorb the effects of the disruption, the lower their vulnerability to that particular hazard (Burton, Kates & White 1993; Oliver-Smith 1999). This ability to adapt to, or overcome hazardous events is a product of the population’s culture and affluence. Culture determines the willingness to adapt in some capacity, while affluence determines the extent of the resources that can be used in the adaptation process (Blaikie *et al.* 1994; Burton, Kates & White 1993; Oliver-Smith 1999).

Disasters to human populations result in social, physical, and economic losses. In nations or communities where the human losses caused by a disaster are high, the event is defined in terms of the death toll, casualty rate, and degree of homelessness. For example, The Economist (2001) presents a table of “Major natural disasters in Central America” in which eight natural hazard events (four earthquakes, two hurricanes, a mudslide, and a flood) each resulted in more than 1000 deaths. Yet, as the article (Economist 2001, 31) states: “how fast [a country] recovers depends less on how much aid it gets than on how well it has planned, in every area of policy, for the tragedy.” In the U.S., unlike Central

America, there has been a shift toward developing complex emergency preparation, response, and mitigation measures in the last 50 years (Platt 1999). As a result, there has been a substantial decrease in the death toll from catastrophic events. For example, the estimated death toll from the Galveston Hurricane of 1900 is 6000 fatalities (Bixel & Turner 2000, Larson 1999). Hurricane Andrew, in August 1992, officially caused only 61 deaths, even though the population at risk numbered in the hundreds of thousands (West & Lenze 1994). Consequently, U.S. disasters tend to be defined by *economic* costs, rather than by *human* or *social* costs (Comerio 2000, Kelly 1997, Winsberg 1996), despite a tremendous amount of research into the human and social repercussions of disasters (Peacock, Morrow & Gladwin 1997; McDonnel *et al.* 1995; Oliver-Smith & Hoffman 1999). Table 3 presents the death toll and monetary toll of Hurricanes Hugo, Andrew, and Floyd, the three most destructive hurricanes to hit the United States in the last 20 years.

Table 3—Comparisons of Death and Monetary Tolls of Hurricanes Hugo, Andrew, and Floyd

Hurricane	Year	Death Toll	Monetary Toll
Hugo*	1989	86	\$30.5 billion
Andrew*	1992	61	\$8.5 billion
Floyd**	1999	77	\$6.0 billion

* adjusted to 1996 dollars (NHC 1999a, 1999b; NCDC 2000)

** only for the state of NC (FEMA 2000b)

Indeed, this tendency toward viewing disasters in terms of dollars and budgets, rather than as victim relief, has led some to question whether the extensive response measures are “worth their costs” (Comerio 2000, Platt 1999, Pilkey & Stutz 2000, Sparks 2000). One differential between the outcomes of disasters that affect the U.S. versus those in

inadequately developed nations is due in part to the actors involved in natural hazard planning and response.

Who are the Actors after a Natural Disaster?

The response generated after a disaster occurs depends in large part on the actors involved in the recovery process. There are three types of actors that participate in the recovery and reconstruction after a natural disaster: institutional resource managers, intermediaries, and victims. It is during the reconstruction and recovery of a community after a natural disaster that the foundation is laid that either reduces or increases the risk of future hazardous events becoming disastrous. The choices made by each of the actors in the recovery process affect the long-term vulnerability of the community as a whole. For example, government resource managers can institute changes in building and zoning requirements. This, in turn, can reduce the number of deaths, injuries, and the costs associated with structural failure during a natural disaster. On the other hand, unscrupulous intermediaries, such as unsavory building contractors, may fail to adhere to the new regulations, thereby jeopardizing the safety of residents. Finally, victims that choose to ignore the risk of a repeat event can opt to rebuild their destroyed home in a known hazardous location despite the loss suffered because of the disaster. The following sections discuss the roles of institutional resource managers, intermediaries, and victims in more detail.

Institutional Resource Managers

The most influential group of actors in a community's recovery process is the institutional resource managers. They represent the institutional agencies that manage and

control the oversight of hazardous events. They operate in two domains: (a) disaster relief, response, and recovery, and (b) disaster prevention or hazard mitigation. These institutional agents have *distribution authority* over much of the resources wielded in natural hazard prevention, preparation, and response processes. In other words, the institutional resource manager has the power to decide who gets what. In the highly constrained setting of a disaster zone, where supplies are limited and difficult to replace, the institutional resource manager can influence the outcome of the recovery process. This is true whether the supplies in question are food and water, construction materials for shelters, medical supplies, or financial support of local government reconstruction and “economic stimulus” projects. In terms of disaster relief and response, the institutional agents include local, regional, and national governments, military organizations, the Red Cross/Red Crescent Societies, the United Way, and other highly recognized, international, institutional groups such as Doctors Without Borders. Agencies such as the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) also work within the domain of hazard prevention or mitigation. These organizations operate in a bureaucratic manner, and each has its own system of protocols that must be observed by those that interact with it.

While these agencies are characterized by their bureaucratic nature, there are some settings in which the cultural and socioeconomic background of the representatives of institutional resource managers affects their interaction with intermediaries and victims. For example, during the recovery from Hurricane Andrew, the U.S. Army established field kitchens to feed the victims living in the tent cities. Yet many of the victims were unfamiliar with military cuisine, particularly those victims of Hispanic or

Haitian background (Yelvington 1997). Likewise, the military was able to rapidly construct tent cities, but unprepared to accommodate the handicapped victims of Andrew (Neal & Phillips 1995).

On the other hand, the “culture of bureaucracy” and its dependence on copious amounts of paperwork create additional problems for integration of intermediaries and victims within the recovery process (Neal & Phillips 1995). This includes the following:

- Unfamiliarity with the aid-seeking process for each organization
- Unfamiliarity with eligibility requirements for assistance from each organization
- Inexperience with interacting with aid agencies, and their respective organizational protocols
- Demand for supporting documentation which was lost or destroyed by the disaster
- Ignorance of the “appropriate” order of aid agencies from which to request assistance
- Cultural views of assistance
- Institutional objectives clash with those of the victims or local community.

Disasters require an understanding of the aid-seeking process (which the average citizen does not have). Those victims who are unfamiliar with eligibility requirements may not apply at all, even though they are entitled to assistance. Likewise, those who are not entitled may spend a significant amount of time and energy filling out the application for assistance and obtaining the supporting documentation when they were not eligible in the first place. This unfamiliarity with seeking aid is not limited just to victims. For example, aid was delayed in arriving to southern Florida after Hurricane Andrew because the governor of the state assumed that a phone call was sufficient to initiate the process. In reality, there were forms that needed to be filled out and submitted before federal assistance could be rendered (McDonnell *et al.* 1995; Peacock, Gillis, & Girard 1997; Peacock, Gillis, & Ragsdale 1997).

Additionally, requests for aid demand a certain amount of documentation in support of the request. This may include proof of residency, such as an apartment lease, a

home mortgage, an electric bill, or even a driver's license. However, these records may have been destroyed in the disaster. If the originator of the documentation (such as the landlord or the bank that issued the mortgage) had its records destroyed, then the request for assistance is further hampered. This assumes that the victim is culturally predisposed to seek aid. Many immigrants are unwilling to seek aid after a disaster, even though they are eligible, over fears of deportation. Other victims may distrust aid providers, and therefore not request assistance. Finally, those in need of assistance may not realize that when requesting assistance from the federal government, there is more than one agency that must receive the request *on its own forms*. Therefore, there is no standard, single application for assistance. The victim must complete *multiple* requests for aid, each complete with its own copy of supporting documentation. Furthermore, these agencies must be applied to in a specific order. Victims must be denied assistance from other agencies before FEMA will review their FEMA application for aid (FEMA 1993; McComas 2000; McDonnell *et al.* 1995; Peacock, Gillis, & Girard 1997; Peacock, Gillis, & Ragsdale 1997, Wegner 2001).

Furthermore, the agenda of institutional agencies may differ from that of the affected community (Middleton & O'Keefe 1998, Oliver-Smith 1986). For example, the methods of floodplain management or wildfire hazard reduction may be at odds with an individual's expectations of the usage of his private property; hazard management strategies may also fly in the face of government or business objectives of increased development (FEMA 1987, Godschalk 2000, USACE 1998). The power distribution among the three types of actors is discussed in subsequent subsections of this chapter.

Intermediaries in Disaster Recovery

The intermediaries, unlike the victims, do not directly experience the event itself. They do, however, affect the outcome of the event. They are distinguished by their role in the recovery and reconstruction process, and their lack of government affiliation. They actively participate in the restoration of the physical and psychological wellbeing of the community. This group of actors includes members from three different arenas: the business arena, the volunteer arena, and the research arena. Business intermediaries are perhaps the most easily recognized in the aftermath of a hazardous event. Much of the recovery and reconstruction of a community is driven by the marketplace (Comerio 2000, NRC 1999, West & Lenze 1994). Families and firms contract out those tasks that they are unable or unwilling to tackle themselves. Consequently, insurance adjusters, moneylenders, and providers of supplies, labor, or other goods or services are important elements of the disaster recovery process. This is not to say that each of these intermediaries is an honorable participant in the recovery process; merely that they have a role in the recovery process.

Nor are intermediaries limited to those who are contractually involved in repairing the damage wrought by the disaster. Volunteers from formal or informal groups—but not institutional agencies—also transform the outcome of a disaster.¹ Formal, noninstitutional volunteers include people from church groups or community associations that arrive at the impact zone to offer assistance. This assistance may take the form of repairing structural damage caused by the disaster. Or the volunteer may be a mental health worker who provides counseling to victims who are having difficulty regaining their emotional equilibrium after the disaster. Like informal volunteers, these groups are

not operating under the auspices of an institutional resource provider. Informal volunteers are those who opt to assist victims despite their lack of ties to any sort of group or organization whatsoever. For example, after both Hurricane Hugo and Andrew struck the U.S., I knew of individual truck drivers who offered to drive supplies to the impacted communities for free, even though they were not formally contacted to do so. These men took it upon themselves to collect donated items for delivery to aid redistribution centers in the impacted areas.

The last type of intermediary is the researcher. Researchers arrive at the disaster site after a hazardous event has occurred in order to study some facet of the hazardous event. It may be the process of the event as it unfolded, the causes of the event, or some feature of the event's outcome. These actors play an important role in the long-term effect of the hazardous event because the knowledge they acquire and disseminate may ultimately modify how a community prepares or responds to hazards. Their findings can influence the development of mitigating structures or policies, resulting in a reduction of risk to the community by natural hazard events.

Each of these three groups of intermediaries has some influence over our perceptions of hazards, our preparations for hazardous events, or responses to disasters. Most of the intermediaries are either semiskilled or skilled, and they are typically not grouped in terms of traditional socioeconomic characteristics. Rather they are defined in terms of their role in the disaster response and recovery process, or the study of disasters.

Victims of a Natural Disaster

The final group of actors within the disaster recovery process is the victims. They are those individuals who directly experience the hazardous event. This group can be

quite diverse; there may be a significant degree of cultural, social, economic, or demographic disparity among victims of a hazardous event. On the other hand, if the event was relatively limited in geographic scope, then the affected population may be somewhat homogenous in its characteristics. For example, a wildfire may destroy a small subdivision in which the residents possess somewhat equivalent traits, while an earthquake or hurricane may devastate a region inhabited by groups of great demographic diversity. Typically, after a catastrophic disaster there is a somewhat brief period (of a few days or weeks) in which the victims develop a unified perception of themselves. As normal routines are reestablished over time, however, most communities recreate many or all of their previously established social distinctions, including those of power distribution (Oliver-Smith 1986, Davis 1986). The power distribution among actors within disaster recovery is presented in the subsections that follow.

Power of Victims

The *power of victims* to affect the outcome of the disaster-response processes is most often reported as negligible or as having been circumvented by the various entities in charge of resource allocation and distribution after a disaster. Most often it is the institutional actors that restrict the participation of victims in the recovery process (Davis 1986; Haines, Hurlbert & Beggs 1996; Oliver-Smith 1986; Peacock, Gillis, & Ragsdale 1997). But this is not always the case. As overlooked victims organize into “emergent groups” and actively promote their needs, the disaster-response mechanism modifies its structure to accommodate the needs of these groups (Dyer & McGoodwin 1999, Fischer 1998). On the other hand, those victims having strong social networks, such as strong family ties or membership in a community or religious group, are better able to address

their own needs; they are also better able to access recovery-process information (Haines, Hurlebert & Beggs 1996; Kaniasty & Norris 1993; McDonnell *et al.* 1995).

Power of Intermediaries

The *power wielded by intermediaries* after a hazardous event varies with the group of actors involved. The intermediaries usually must compete against the authority of the institutional agencies. For example, some emergent groups have difficulty “getting the word out” about the resources that they can provide, because most victims associate disaster aid with the Red Cross or FEMA, and not with a newly formed local group (McDonnell *et al.* 1995). Unfortunately, there are many examples of institutional figures deterring or preventing volunteer intermediaries from rendering assistance. A minor example is volunteer carpenters and other northern tradesmen who arrived in South Florida through church affiliations were not allowed to work on repairing damaged homes because they were not licensed to work in South Florida (Dyer & McGoodwin 1999). A tragic example occurred after the Mexico City earthquake of 1985, when military and government representatives actively prohibited local volunteer groups from searching the rubble for survivors (Robinson *et al.* 1986).

Power of Resource Managers

For institutional agencies (those responsible for managing resources), the access, control and distribution of aid gives them tremendous power. But even this has its drawbacks. Site selection for distribution centers must account for victims’ various impediments that hinder their attempts to reach the distribution center. Coordination of activities among various institutions is never smooth. Competition for resources among agencies, intermediaries, and victims can lead to conflicts of interest or simply to

overlooking populations in need (Carney 1993, Fischer 1998, Middleton & O'Keefe 1998, Neal & Phillips 1995).

Likewise, resource managers may act to further their own institutional agenda. Often this is a political agenda. As the elections of 1994 neared, pressure was placed on FEMA by "the federal government" to close the tent cities in Homestead, even though there were still over 1000 people without shelter because of Hurricane Andrew (Yelvington 1997). These institutional agencies may also use the disaster as a political device by creating a "showpiece" community in disaster's wake. After the destruction of the Huaylas district of Peru from a catastrophic earthquake, the Peruvian government built an urban district center with modern infrastructure improvements where before had stood a modest provincial town and outlying villages (Doughty 1986, Oliver-Smith 1986).

There are no clear-cut predictions of the outcomes from a natural hazard event. The tensions among the various actors (victims, intermediaries, and resource managers) may occasionally work at cross-purposes. For example, some communities may want to remain in their community's original location, despite the risk of a repeat disaster. This was the case of the residents of Yungay, Peru (Oliver-Smith 1986). This town was obliterated when a catastrophic mudslide buried all but roughly 500 residents (and all of the town's structures). Despite this tremendous loss, the residents acted out of strong social and cultural conscience when they chose to rebuild on the site of the former town, rather than relocate elsewhere. On the other hand, victims may want to relocate to a somewhat distant locale, or to a nearby area, but not the original community location. After Hurricane Andrew, tens of thousands of residents voluntarily moved away. Those

that held jobs in Miami or nearby cities relocated to the city's suburbs or just across the county line to Broward County. Most of the remaining "disaster emigrants" moved to northern Florida counties, with just a small percentage leaving the state altogether (Smith & McCarty 1996). And after a catastrophic tsunami in Alaska in 1964, residents from one of the destroyed villages were reluctant to return to their original community site, although they expressed a willingness to relocate to an area nearby (Davis 1986).

Needless to say, a community's overall response to disaster heavily influences the rate and manner of change that the community will experience for years to come. Alteration of the landscape in order to lessen the risk from a repeat occurrence (such as by building a levee to protect against flooding) typically shifts the burden of risk to another population elsewhere (FEMA 1987, USACE 1998). High rates of out-migration can leave a community with but a shadow of its former vitality. And rearrangement of subgroups within the community through voluntary or involuntary relocation efforts permanently changes the geographic and cultural interactions among community residents.

Indeed, relocation of a vulnerable population or community can exacerbate the victims' psychosocial difficulties due to what Hewitt refers to as "uprooting" (1997, 44). The deeper one's roots in a home, a community, or a region, the stronger one's attachment to that place. Disasters sever this tie either temporarily or permanently, resulting in evacuation and/or homelessness. "The gravest losses for most people in public disasters are still those affecting the home and home area. So often this is the space that decides, or comes to signify, the disaster" (Hewitt 1997, 46). Uprooting of a household is at the very core of the loss of normality during a disaster's aftermath. For

example, while the residents of eastern North Carolina recovered from the flooding that occurred in 1999, those who were able to remain in their damaged homes while repairs were made recovered emotionally at the same rate as those whose homes were not damaged at all (Wilson *et al.* 2001).

Clearly, researchers in the natural sciences are actively expanding our understanding of the geologic, hydrologic, and meteorologic processes involved in natural hazard events. Likewise, social scientists developed a broad and deep body of research into the changes wrought on and by individuals, groups, or institutions after a disaster strikes. Interestingly, there is little information on how businesses are affected by disasters, or how they respond to disasters. The next chapter discusses this in more detail.

Notes

¹ Many institutions, such as FEMA, the Red Cross, and Doctors Without Borders, rely heavily on the work of volunteers. However, this group of volunteers has access to resources (and therefore power over their distribution) that other volunteers lack. Consequently, for this report, institutional volunteers are considered to be resource managers, rather than intermediaries in the hazards response process.

CHAPTER 3 BUSINESS CONSIDERATIONS

How do businesses respond to a natural disaster? Very little is known, as this topic has not been previously researched. The objective of this study is to explore the manner and methods of business response to disasters within the framework of a case study. Since no previous research specifically addresses this question, the literature has been examined for information that provides insight into the relationship between affected firms and their recovery decisions. This assumes that the firm is not forced to close its doors permanently because of the disaster. Indeed, while this does occur, the research question, by definition, requires that a firm survive the disaster event in order to develop some type of response to the event's impacts.

A variety of response options are available to surviving firms; these vary in accordance with: the type of disaster, the severity of the impact to the firm, the duration of the impact to the firm, the impact on employees, the impact on customers, the impact on suppliers, the changes in the regulatory environment, and the availability of capital necessary to enable a firm's reconstruction and renewal activities. Two major types of business responses possible are operational and geographic. Deciding to remain in operation at less than full capacity, or to suspend operations temporarily, are operational responses. Relocating part of all of the firm's operations (either temporarily or permanently) is a geographic response. This chapter discusses the theoretical concepts

used to establish the research objectives for this study. It is presented in three major sections: Firm Survival, Relocate or Remain, and Drawing on Available Resources.

Firm Survival

Survival refers to a firm's ability to return to economically viable operations after severe or prolonged business interruption due to a natural disaster. This might require the repair or reconstruction of the building(s), repair or replacement of equipment and inventory, supplementing any labor shortages, and restoring successful production, marketing, and distribution functions. Dahlhamer and Tierney (1998) examined firms impacted by the 1994 Northridge Earthquake in an effort to quantitatively assess which attributes of a firm contributed to its survival from the disruption caused by the earthquake's destruction. An important caveat about this study must be made, however. This study did not attempt to distinguish firms that experience a significant setback due to the disaster, from those that enjoy the "economic boom" of recovery operations, such as construction, retail, and auto sales and repair. For instance, in the aftermath of a disaster that causes tremendous structural damage, construction firms will be so flooded with contracts for services that they cannot satisfy the market's demand. The Northridge study grouped manufacturers and construction firms together within the same overall category. Consequently, some of the results were not as strong as expected for such a large sample size (n=1110). Indeed, they point out that their model also does not accurately classify those firms that did not recover to predisaster levels.

Limitations notwithstanding, the study does demonstrate some important characteristics of firms that successfully renew operations after a disaster:

- Size of the firm
- The intensity of ground shaking
- Proximity to a destroyed area

The strongest indicator was firm size, with larger firms having a higher rate of recovery than smaller firms. “It appears that size helps insulate firms not only from other sudden perturbations in their environments, such as interruption in the flow of supplies or sudden market downturns, but also from the negative effects of disasters” (Dahlhamer & Tierney 1998, 134). The intensity of the earthquake’s shaking, which can also serve as a proxy for degree of firm and neighborhood damage, was another important indicator. The third factor was more geographic in nature, and affected small firms the most: proximity to a destroyed area. This was particularly troublesome for firms that were dependent on a local market that was forced to evacuate or relocate when buildings were condemned—even if the firm itself was undamaged. The earthquake essentially resulted in an instantaneous loss of market. Although the authors did not pursue this facet of the study, it does raise an interesting question: was it one factor (proximity to destroyed area), or some combination of factors that led to problems of resiliency for undamaged firms located near centers of destruction? Some other possible factors that may contribute to firm resiliency under these circumstances include: firm size, the degree of destruction of the nearby area, the firm’s type of market, and the firm’s type of industry (e.g., a retailer selling an end-product, versus a wholesaler selling an input to another firm).

Their study also suggests that at least one element could be an indicator of a firm’s failure to thrive in the months following a disaster: receipt of government assistance. However, because of modeling problems, it is not clear if receipt of government aid negatively impacted firms by creating too much debt burden for a firm in

the immediate aftermath of a disaster (but which may remedy itself over years). Or perhaps the firm was only marginally successful before the disaster, and the government assistance merely sustains an operation that the market is not able to sustain. Another unfortunate limitation to the study (from an economic geography point of view) is that it did not evaluate those firms that relocated as a result of the disaster.

Relocate or Remain

Unfortunately, to date firm survival studies do not indicate whether or not the firm opted to remain in operation at its original site. These studies assume that a firm that survives a disaster will automatically remain in operation in the affected community. Given the ability of firms to relocate, such assumptions regarding firm behavior may be inappropriate. A business may find that there are various economic disincentives to remaining at the original site, or even within the affected community after a disaster. These incentives may be driven by supply-side or demand-side factors. For example, manufacturing enterprises may obtain cheaper labor or greater land availability in another locale. A service provider, on the other hand, may be closer to its clients if it moves. Or there may be management considerations that influence a firm's location choice after a disaster occurs. For instance, the time required for the reconstruction of facilities may take so long that the firm may risk losing its clients to its competitors if it rebuilds rather than relocate. All of these examples are themselves influenced by the degree of damage sustained by the firm when the disaster strikes.

For those firms that survive a disaster, what can be predicted about their location decisions in the aftermath? At this point, very little. Despite the array of research on natural hazards, to date no studies have examined business location decisions in the

aftermath of a disaster. However, in terms of business location decisions made under more normal circumstances, two separate groups of factors are typically studied: traditional business factors and “embeddedness” factors. There are also disaster, or business disruption factors, that may influence a firm’s relocation decision.

Unfortunately, the relationship between disaster impacts and firm relocation has not yet been examined. Each of these is discussed individually in the subsections below.

Business Factors

Traditional economic theory assumes that firms will behave in an individualistic manner in response to economic stimuli. Each response will be geared towards maximizing profit. Under this assumption, purely economic considerations will influence firm retention. These business factors may be location-specific in nature, or firm-specific. A location-specific example is the cost associated with available labor (Braconier & Ekholm 2000). Thus, the costs needed to restore operations in the predisaster location can influence whether or not the firm remains in the host community. If these costs are less than the costs needed to initiate operations elsewhere, then the firm will be more likely to stay in the impacted community. Likewise, if the time needed for a contractor to be hired and complete necessary repairs or improvements is excessive, there will be an economic incentive to shift operations elsewhere.

Firm-specific traits refer to the attributes of the firm itself. Firms in the impact area can be stand-alone establishments (such as a “mom-and-pop shop”), or part of a larger entity, such as a branch plant or a franchise. There are a variety of different firm-specific factors that can affect a firm’s postdisaster decision-making. One set of firm-specific factors includes the type of firm (stand-alone, subsidiary, franchise, branch

plant), and the length of business interruption incurred (Gordon *et al.* 1995, Tierney 1997). For example, a branch plant has a wider array of corporate resources upon which to draw than does a small stand-alone establishment. In cases where the length of interruption lasts weeks as opposed to days, the stand-alone could fail altogether. Another set of traits are facility-specific, and include the facility's distance to the corporate headquarters, the diversity of activities occurring at the facility (such as marketing, purchasing, or research and development), or the size of the facility relative to others within the corporation's control. In this instance, facilities that are far from corporate control, and which are relatively small compared to others within the corporate domain may be more likely to be "downsized" or closed altogether (Watts & Kirkham 1999). A third important consideration is a firm's planning horizon. For instance, a firm's cost-benefit analysis over a 20-year planning horizon will differ from one with a 10-year horizon. In the short term it may appear to be cheaper to stay in the predisaster location, yet in the long run it may actually prove to be more expensive. For example, if the firm's owner is planning to retire in 5-10 years, he may be less willing to take on an extended loan for business improvements.

Within the traditional business network, relationships are contractually bound and exist only as long as the contract exists. Transactions among member firms occur at arm's-length. The hierarchical organization of vertically integrated firms illustrates the arm's-length approach to business interaction. Any penalties for changing partners within contractual networks are typically worked out during the contract negotiations. As a result, a firm bound only by a contract can effectively analyze each opportunity for switching business partners in order to maximize profit at the potential expense of

partners. This arm's-length relationship is in stark contrast to those seen in embedded networks (Uzzi 1997, 1996).

Structure of an Embedded Network

The structure of an embedded network is unlike that of a traditional business network. Van Kooij (1990) argues that embedded networks have a cobweb structure, rather than pyramidal one seen in hierarchical networks (Figure 1). The linkages within this embedded structure are typically between a firm and its suppliers, customers, and other clients. However, these linkages are not necessarily limited to linkages within only one industry. For instance, a Japanese auto manufacturer may have ties to a beer producer within the overall structure of the embedded network. This cobweb structure creates socially oriented, mutual interdependencies. These mutual interdependencies reflect the cooperation among firms. Interdependency is illustrated by the ratio of business activity that is routinely shared solely with network members. By restricting these transactions to network members only, the firms reinforce their interdependence. This "group orientation" requires a different form of cooperation than that which is seen in a vertical network (Van Kooij 1990, Sako 1996). Yet, as already mentioned, it also allows member firms "to combine resources in unique ways" in order to gain a competitive advantage (Dyer 1998, 660).

Embeddedness Factors

It is not just traditional business factors that influence firm behavior. Typical economic transactions are expected to occur with a minimum of social interaction, and a limited development of "goodwill" (Dore 1983). Embedded networks, on the other hand, are entirely structured within a social context. There is an overarching ethical code

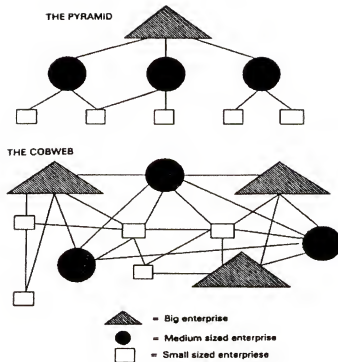


Figure 1—Pyramid and Cobweb

Source: van Kooij, 1990, 298

among network members, in which their trustworthiness and reliability are requirements for continued membership (Graher 1993, Håkansson & Johanson 1993, Sako 1996).

Becoming a member of an embedded network is difficult. An existing member usually must recommend the potential new firm to a network member. With each transaction, the potential member must demonstrate his reliability, thereby earning the trust and cooperation of the network before becoming a full member of the network (Sako 1996, Uzzi 1997, 1996). In some countries, such as Japan, the cultural behavioral codes act as an additional barrier to foreign firms that would like to join a network of embedded firms (Sako 1996). Another behavioral barrier to entry into an embedded network is the “know-how” of cooperation (Kogut, Shan & Walker 1993). Embedded

networks are limited by the willingness of firms to participate in a network that requires a high degree of trust and cooperation. For example, member firms in embedded networks do not frequently switch partners in order to generate the maximum possible profit. Those firms possessing little experience with socially bound transactions lack the expertise needed to interact in an embedded network. This lack of cooperative know-how limits the number of potential new firms that can join the network.

Embedded networks operate much more closely than traditional business networks. The ties among members of embedded networks are socially bound, rather than contractually bound. (This is not to say that they operate without business contracts, but that the contract is of secondary importance to the business transaction.) As a result, there is a higher degree of trust and cooperation among embedded firms. This reduces the level of uncertainty in negotiations, and facilitates information and resource exchange. Information exchange provides a forum for “interactive learning” among embedded firms (Hakansson & Johanson 1993; Kogut, Shan & Walker 1993; Maskell & Marnberg 1999). This learning involves mutual problem-solving activities (such as sharing engineers in order to resolve a production problem). The expertise gained, and the increase in trust, create valuable, intangible assets for the networked firms.

Cooperation within an embedded network

Resource sharing is but one of the benefits of membership within an embedded network. In Uzzi's (1997, 1996) studies of the New York City garment industry, he found several examples in which embedded firms chose cooperation over economic opportunism. In one case, a manufacturer was willing to assist a network supplier in obtaining a loan for new equipment that would keep the supplier competitive, rather than

to buy the same supplies from a nonnetwork competitor who offered them more cheaply. In another example, a network member “lent” engineers to another network member in order to resolve a manufacturing problem, even though the problem did not impact the former firm. Resource sharing among members may also include some technology transfer or management training (Dyer 1998, Sako 1996, Uzzi 1997).

Firms involved in such embedded networks value this high degree of cooperation. The shared problem-solving efforts of members are particularly advantageous for small or innovative firms (Malecki & Tootle 1997, Van Kooij 1990). These firms do not always have the physical or knowledge resource base to accomplish their objectives. By working together, however, they not only accomplish their goals, but they also “cross-fertilize” their intellectual base and increase the store of “tacit knowledge” available to them for solving future problems. Information exchange among embedded firms can supplement or substitute for interactions with formal institutions, such as university research centers. Since firms in embedded networks are accustomed to assisting each other in order to resolve the problems facing one or more members, it is likely that if faced with a natural disaster, these firms would work together to overcome their difficulties. Through mutual problem-solving and resource-sharing, embedded networks may, in fact, increase the survivability of member firms in the wake of a disaster.

Firm survival in an embedded network

Embedded networks are relevant to this research because they generally offer higher chances of firm survival (Uzzi 1997). As Granovetter (1985, 507) states, “small firms in a market setting may persist ... because a dense network of social relations is overlaid on the business relations connecting such firms and reduces pressures for

integration.” This research proposes that the increased potential for survival of an embedded network will contribute to the economic resilience of a community after a disaster, since members in an embedded network are not likely to make location decisions in isolation. Rather, they are likely to factor in the decisions of their network members before implementing their own decision. Since embedded networks involve firms with cooperative links, embedded firms tend to establish networks among suppliers, vendors, and others; they enjoy benefits not necessarily seen in an impersonal marketplace. Some of these benefits are cooperative adaptation strategies, such as resource sharing or intranetwork loans, that can be employed to deal with unexpected events, like a disaster.

However, embedded networks are not without their drawbacks. They require a certain degree of geographic proximity (Kogut, Shan & Walker 1993) and they are less frequently seen in industries that produce highly standardized or “mature” products (Lundvall 1993). In addition, the formal and informal entry barriers restrict new membership (Grabher 1993, Uzzi 1997). This, in turn, limits the degree of interactive learning that takes place. Consequently, embedded networks exhibit a “tendency [for their] learning to decline with time” (Kogut, Shan & Walker, 1993, 7). This plateauing off of the network’s adaptive learning ability may influence its response to a disaster.

Disaster Factors

The third type of general factor that can influence a firm’s decision to remain or relocate after a disaster are those that are directly associated with the disaster itself. Unfortunately, these factors have not been examined in this manner before. Generally

speaking, there are six categories of disaster factors that reflect the overall manner in which a disaster can disrupt business activity:

- Disruption of staff availability
- Disruption of infrastructure
- Disruption of inputs
- Disruption of customer base
- Alteration of the regulatory environment
- Disruption of capital flows.

There is no clear cut dividing line separating these categories. Indeed, in the aftermath of a disaster, there may be some degree of overlap among the categories. Nonetheless, there are general distinctions that can be observed for each one. Staff disruption may be the result of employees who are difficult to locate because the disaster rendered them and their next of kin homeless. Often, the suddenly homeless must struggle with obtaining the capital needed to reestablish some type of “home” somewhere. If the housing market is tight (e.g., there are few affordable apartments, and few or no affordable homes on the market), then the homeless employee(s) may end up migrating between the homes of family and friends in the months (or years) following the disaster.

Infrastructure disruptions include the loss of transportation routes, communications, utilities, water, sewage treatment, and trash (debris) collection. In some cases there are viable alternatives if a disruption occurs. Should the electricity go out, a generator (if available) can be used. If water supplies are shut off, bottled water can be brought in. Cell phones can replace regular phones—but only if there is electricity to recharge the battery, and if the cell phone tower and satellite remain operational. A major problem arises for firms (and everyone, for that matter) if the transportation access routes are cut off by the disaster. Flood, landslide, earthquake, lava flow—anything that

geographically isolates a firm from its market, its providers, or its staff can strangle the firm.

Another way that the flow of inputs can be disrupted is if the disaster impacts firms up and down the supply chain. If the customer base is composed of firms that are all impacted by the disaster, this can result in a serious disruption to a given firm. On the other hand, if the customer base is comprised of individuals or households, any relocation of this population (especially if it is prolonged or permanent) can likewise severely affect a firm.

Frequently, disasters result in a significant change in some portion of the regulatory environment. For example, building codes are usually “beefed up” after a disaster. After the flooding of 1999, Greenville, North Carolina increased its minimum required building elevation for structures built within the 100-year flood plain. It is now at a higher elevation than federal standards require.

Finally, the disruption of capital flows can severely hamper a firm’s ability to restore operations. Firms can wait months before receiving money from an insurance settlement or from government assistance programs. Firms having little or no revenue flow as a result of business disruption still have bills to pay (and more bills than before the disaster). Consequently, their financial well-being can be a strong influence on reconstruction or relocation decisions.

Drawing on Available Resources

Firms that participate in some type of network can access a broader array of resources than a stand-alone establishment. If the network is a hierarchical alignment of completely integrated establishments (such as franchises), or closely coordinated yet

independent establishments (such as vertically integrated producers), these establishments can attempt to tap into the knowledge, expertise, and other resources in order to restore normal operations as quickly as possible. As a result, firms engaged in an embedded network lack the rigid contractual obligations seen in a hierarchical network, and have overriding social requirements that facilitate a greater degree of aid provision to members.

What if an establishment is not part of any network? In many cases it comes down to size: the size of the establishment itself, the size of the management force, and the size of the bank account. A stand-alone enterprise that is large enough to have multiple facilities in various locations can redistribute its operations among the other facilities much like a hierarchical network can. If the stand-alone has only one work site, but the facility is extensive, with a large labor force and multiple levels of management, then the firm may have enough human resources available to develop alternative coping strategies (rather than shift operations elsewhere). These strategies may include deploying damage and salvage assessment teams in order to limit the losses incurred by the disaster. The firm may also develop in-house strategies for helping their employees cope with the emotional trauma and bureaucratic requirements of obtaining assistance. But this type of postdisaster activity requires some degree of “extra” management that can be pulled off of their normal duties, and assigned to disaster recovery duties instead. If the stand-alone firm is a “one owner–one manager” type of operation, this depth of manpower may not be available. Thus, the coping strategies are much more limited. In these cases, especially, the size and strength of the bank account before the disaster matters. The deeper the pockets the longer the firm can withstand a disruption of business. If the firm

is marginally profitable, such as some farms, and some mom-and-pop type businesses, a disaster can instantly put them out of business. The President of the North Carolina Rural Economic Development Center reported that over 1000 farmers in eastern North Carolina had to publicly admit that they were facing bankruptcy in the wake of Hurricane Floyd.¹ In addition, there are a large number of mom-and-pop firms that are completely lacking in formal business management expertise. These business managers learned the business from watching their parents and other family members. Many quit school while young in order to work in the business full time. They understand the day-to-day nitty-gritty of business: ordering more supplies, marketing new products, paying wages, and so forth. What they do not know is how to draw up a business plan, or even a formal budget for a year's operation. These types of documents are needed in order to secure a loan (which many of these owners have never needed before), or to obtain assistance from any government agency.

This brings up the final point about drawing on available resources. The federal and state governments make available a variety of financial and technical assistance for businesses that suffer from a disaster. These institutions are seen as the "lender of last resort" and indeed usually require applicants to have been turned down by more than one commercial lender before the applicant can be considered for a low interest loan (or the less frequently given assistance grant). Yet in areas where businessmen lack the expertise needed to produce the required documentation to accompany the application for assistance, the assistance itself is reduced to an invisible resource.

For those that do obtain assistance from the government, this "aid" is typically in the form of a low interest loan rather than a grant. While the firm is fortunate that the

loan assesses interest at a lower than market rate, it is still an additional debt burden for the firm. If the firm is marginally profitable, the additional debt may eliminate the firm's profit margin altogether (Wenger 2001). This belies the question as to the appropriateness of government assistance: how needy is too needy? Some economists would argue that businesses should not be "artificially resuscitated" by the government (NRC 1999). But community planners and advocates for rural areas would argue that the support allows rural communities to continue a long-standing way of life. Without these businesses that service very small markets, even more rural dwellers would be forced to commute long distances for their consumer goods (Delia 2001, Rees 2001b, Wenger 2001).

All of these concepts were used to develop the survey instrument used in this research. The description of the survey, the study area, and the other methodological considerations of this research are in the following chapter.

Notes

¹ It is not clear how many of these farmers diversified into crops other than tobacco. Nor is it known to what extent the risks carried by the farmer engaged in hog farming contributed to these financial disasters. For example, if a farm was flooded in the year after a farmer obtains an extensive loan in order to construct some hog finishing barns, the farm may be saddled with too much debt to be eligible for another loan.

CHAPTER 4 METHODOLOGY

This chapter discusses the methods used in collecting and analyzing the data for this research. It is broken into two major sections: Research Description, and Research Problem. The Research Problem section is further broken down into four subsections: Research Questions, Data Collection, Data Entry and Data Analysis. Two of these subsections, Data Collection and Data Entry, are themselves subdivided. The Data Collection subsection presents a description of the study area, the methods for selecting participants, the development of the survey instrument, and the problems that arose with the survey instrument. The Coding of Data subsection discusses the methods used in coding the original variables, and those used in recoding variables. It also discusses those variables that could not be recoded, and those variables omitted from the analysis.

Research Description

There is limited research into the economic dynamics that occur in the aftermath of a natural disaster. Some of this research attempts to develop quantitative models to measure the economic behavior observed after a disaster (Guimaraes, Hefner & Woodward 1993; West & Lenze 1994). Others attempted to develop predictive factors of firm survival after a disaster (Dahlhamer & Tierney 1998, Tierney & Dahlhamer 1996). Often these studies are couched in ways that put a “positive spin” on the economic effects of the disaster. They emphasize the “rebound” a community experiences from the “economic boom” of recovery (Dahlhamer & Tierney 1998, MDPD 1996). Even the

media periodically promote an “all’s well that end’s well” view of the economic aftermath of a disaster (Tomsho 1999).

However, some disagree with this rose-colored view of the postdisaster economy (Guimaraes, Hefner & Woodward 1993). The economic recovery phase from disasters relies heavily on transfer payments from insurance companies (Guimaraes, Hefner & Woodward 1993; NRC 1999; West & Lenze 1994). Yet migration due to the disruption caused by the disaster can result in a substantial net economic loss (Winsberg 1996). This migration represents not only a temporary loss as the displaced obtain housing elsewhere, but a potentially long-term loss as well. Should the displaced opt to establish permanent residence away from their original community, the community suffers.¹ Communities whose birth rates or immigration rates are not high enough to offset the effect of out-migration will see their economic base contract as a result. The income level of those displaced who move away permanently can also alter the local economy by changing the market demographics. For instance, the loss of numerous upper-middle income residents might result in the closure of local retailers and service providers that cater to them.

This study examines the factors that influence business recovery decisions in the wake of a disaster. An important choice businesses face is whether or not to move their operations elsewhere. By examining the “how” and “why” processes that business leaders follow when determining their postdisaster location decisions, a fuller understanding of business decision-making processes in response to natural disasters can be developed. The “how” process involves a firm’s response to the question: How will it respond to the impacts from this natural disaster? It includes developing a list of possible strategies that address the disaster’s impact and potential repeat occurrence. The “why” process

involves a firm's "process of elimination" in determining which of the alternative response strategies are actually implemented.

This research hypothesizes that those factors that relate to a firm's embeddedness in a network also contribute to a firm's response while recovering from a disaster. One example is the firm's willingness to remain in a disaster zone after a disaster strikes. A firm's embeddedness is reflected in the extent and strength of industry ties that the firm enjoys. Embedded firms are closely linked in their economic behavior. Their strong ties of trust allow firms to cooperate with other network members, even when the immediate circumstances do not offer obvious economic benefits. Factors of embeddedness include the extent of integration of a firm within local business clusters (or networks), the amount of coordination of its business activity with network members, and the degree of shared problem-solving (Uzzi 1997, 1996).

At the community level, the implications are that if several firms in a locality are highly embedded (tightly connected), then an individual firm among them will be more likely to act in accord with the rest of the network when determining that firm's response to a disaster. Therefore, retention of an embedded network could facilitate a dynamic economic recovery process. Loss of such a network from the economic base would create a difficult economic vacuum to fill, even with the application of state and federal recovery funds. An excellent example is the abrupt closure of the Homestead Air Force Base in South Florida during the aftermath of Hurricane Andrew. Many businesses had been tightly integrated into a network in which the base itself was the hub. Within a hub-and-spoke network the "spoke" firms have few links between each other or to other firms. "Spoke" firms thrive so long as the "hub" of their network thrives (Gray, Golob &

Markusen 1996; Markusen 1996). The local Homestead firms suffered when their key customer (the air base) was suddenly closed. Although the local governments (Homestead, Florida City, and Miami-Dade County) initiated several different economic improvement projects, few of them increased employment levels or expanded the remaining business sectors (Dyer 1999). As a result, these programs were not able to adequately offset the negative impact suffered by the communities due to the base's closure.

Research Problem

A loss of any of several components of a community's business sector after a natural disaster has serious long-term economic effects. Four examples are:

- Increase in unemployment levels due to business interruption, relocation, or closure
- Loss of a segment of the working population that moves away in order to maintain employment with a firm that has likewise relocated
- Loss of a segment of the working population that moves away in order to obtain employment after their employer closes as a result of the disaster
- Reduction of the tax base.

Although local governments develop economic recovery projects to assist their business sector during the aftermath of a disaster, the project outcomes are not always successful in achieving their objectives (Dyer 1999, FEMA 1993). This research proposes that an understanding of the key factors that influence firm retention after a natural disaster are necessary in order to develop strategies that maximize the economic recovery of a community. These factors are grouped into three separate categories: *traditional business factors* (such as the firm size or site ownership), *embeddedness factors* (such as the degree of problem sharing by network members), and *disaster factors* (such as the level

of damage sustained by the impacted firm, or the degree of disaster experience). Thus, this research is framed around the five research questions stated below.

Research Questions

1. To what extent does prior experience with a natural hazard (such as a hurricane) affect the outcome of the event (such as the level of damage sustained)?
2. What damaged or disrupted business elements (e.g., production, inventory, transportation systems, or communications systems) most significantly affect the operation of businesses in the disaster zone?
3. Do the establishment's attributes (e.g., number of employees, site ownership) influence the establishment's disaster response?
4. Do business networks influence a firm's disaster response?
5. What issues are the most important for a firm to regain normal operations after a disaster?

In order to answer these questions, the following hypotheses were developed:

Hypotheses

1. The greater the amount of experience with hazardous events, the more effective the level of preparedness for a disaster.
2. The business elements most vital to a firm's survival will have the greatest negative impact to a firm if they are severely damaged or disrupted.
3. Those establishment attributes that influence a firm's disaster response:
 - Traditional business factors, both
 - Firm-specific, and
 - Location-specific
 - "Embeddedness" factors, and
 - Disaster factors.
4. The more embedded a firm is, the greater the likelihood that the firm will make the same choice regarding changing its operational venue as its network members.
5. The less embedded a firm is, the greater the likelihood that the firm's decision regarding relocation will have little impact on other firms to follow suit.

There is no hypothesis for the final research question. So little is known about this subject matter that when the study was being set up, the researcher decided to approach the final question by analyzing the data once it was collected. This way, the study could uncover aspects of postdisaster decision-making by businesses unanticipated by the researcher.

Data Collection

The data for this research were gathered via surveys and in-person interviews with representatives from 49 establishments in a flooded industrial district within the Greenville, North Carolina, Metropolitan Statistical Area. In addition, eight representatives from various local government and nongovernment organizations were also interviewed. North Carolina was selected for this research because it suffered the greatest damage from Hurricane Floyd (FEMA 2000a, b, c). The state also has a strong manufacturing base, although the textile and apparel industry sectors were in decline before Floyd struck. This decline in employment was due in large part to the adoption of more automated manufacturing and foreign competition (NCDOC 2000). Although over 30 North Carolina communities were entirely submerged by floodwaters, most of these were small towns or crossroad communities with a limited economic base (Delia 2001, McComas 2000).

The city of Greenville was chosen for a number of reasons. First, preliminary calls to businesses and government representatives in Wilmington, North Carolina determined that Greenville suffered more extensive damage than other cities closer to the coast. Second, the city has over 60 manufacturers (Harris 2000, NCDOC 2001b, PCDC 1999). Third, Greenville is home to Eastern Carolina University (ECU), which has conducted several studies and two conferences detailing the impacts North Carolina sustained from Hurricane Floyd (Bateman & Edwards 2001; Gares 2001; Wilson *et al.* 2000). Finally, the city is located in one of the counties that FEMA rated as having been “severely impacted” by Hurricane Floyd (FEMA 2000b, NCDOC 2001).

The flooding seen after Hurricane Floyd turned part of Greenville into an island, submerged the rest, and inundated extensive tracts of the surrounding county (PCPB

2000). According to the flood map produced by Pitt County (PCPB 2000), the industrial district immediately north of the Tar River was almost totally inundated with floodwaters. This industrial district officially falls under the Extra-Territorial Jurisdiction of the city of Greenville. Technically it is not an official part of Greenville, but all businesses and residential establishments are required to comply with all city zoning, planning, and building regulations. This industrial district lies within the major floodplain area; according to the map of flooded areas, the businesses in this area suffered the greatest concentration of flood damage than elsewhere in Greenville or Pitt County (PCPB 2000). As a result, the research focused on collecting data from firms within this industrial district.

Description of the study area

The industrial district used for this study has a roughly triangular shape (Figure 2). Its eastern boundary follows the curve of Northeast Greenville Boulevard (US 264A), where the boulevard becomes the northeast portion of the bypass loop. This section of Greenville Boulevard extends from the southeasterly course of the Tar River around to one of the main feeder highways into Greenville: Memorial Drive (US 264/ US 13/ SR11/ SR903). The base of this triangle is the Tar River. However, almost all of the firms that operate in this industrial region are north of Pactolus Highway (SR 33). Pactolus Highway does not directly connect Greenville Boulevard with Memorial Drive. A “dogleg” via Greene Street is required. Greene Street is an older road that provides a north-south shortcut between Memorial Drive (and parts of the industrial district) and downtown Greenville. Although an old road, Greene Street still serves as a major transportation artery to the downtown area.

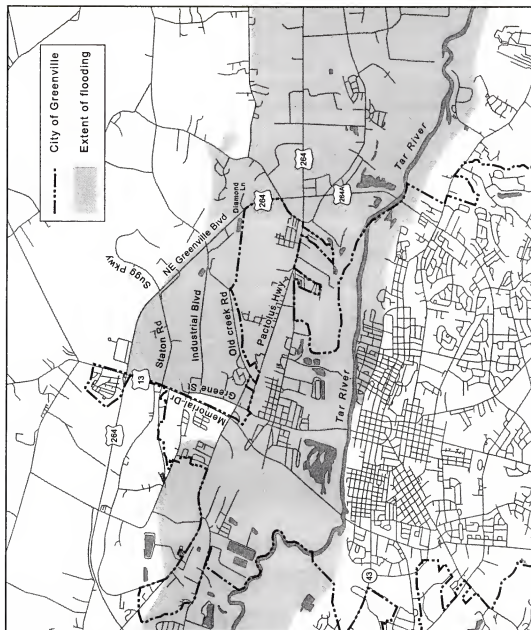


Figure 2-Industrial District North of the Tar River in the Greenville MSA

The dominant industrial area within the study area is the northern portion of this region. Its boundaries are Pactolus Highway, the north section of Greene Street, the north section of Memorial Drive, and northeast Greenville Boulevard. This area is the commercial heart of the industrial district. Located here are the majority of firms that participated in this study. This industry-dominated area has two major east-west thoroughfares crossing it: Staton Road and Industrial Boulevard. A number of large manufacturers are found along these roads, as are several spatially large warehouse or distribution enterprises. Several more manufacturers and distributors are found along that stretch of northeast Greenville Boulevard that extends between the intersection with Industrial Boulevard and the interchange at Memorial Drive. There are several small lanes and cul-de-sacs within this northern section of the industrial district that house most of the smaller establishments that also participated in this study. Other clusters of small establishments were found along Greene Street.

Jutting to the east of northeast Greenville Boulevard are two other “industrial centers.” A very small one on Diamond Lane (Lakeview Industrial Park) had only three small firms located there at the time of the research. A much larger one (Indigreen Corporate Park) is being developed along Sugg Parkway, which is, in fact, an eastward extension of Staton Road. Within this corporate park are medium-to-large branch plants or subsidiaries of either national or multinational firms, and medium-sized local corporations. These two areas were treated as extensions of the study area. All firms within these two areas were visited as part of the research.

The “remainder” of the study area (the area between Memorial Drive and Greene Street, in addition to the area between Pactolus Highway and the Tar River) is a mixed-use area in which single-family residences predominate. The mixed-use area has several clusters of small, older subdivisions, some now abandoned mobile home parks, and numerous spatially dispersed single family dwellings. Additionally, within the mixed-use area there are light industrial, retail, and commercial businesses (some of which are abandoned). There are also churches, a recreational park, and several government facilities (such as the state Department of Highways regional office and service yard, and the local Army Reserve Depot). The scars from the flooding are still present in this mixed-use area two years later. For instance, high water marks are still visible on numerous structures. Unfit for occupancy codes were spray-painted on the doorways of numerous abandoned structures. Indeed, the general decay around those properties that are slated for demolition and removal as part of the Federal “Buy-Out” Program provides a striking reminder of the devastation caused by the flood.²

Within much of the easternmost portion of the study area there are farm tracts still actively cultivated. Indeed, the freeway bypass (US 264A) can be thought of as a barrier between the industrial district and agricultural areas to the north, east, and west of Greenville, as well as the outer boundary of the city limits.

Participant selection

Although all but two of the commercial establishments in the study area were visited, not all of their responses were included in the analysis. Selection of participants for this research was limited to only those firms that are manufacturers or that provide goods and services to other businesses, rather than to households or individuals. For

example, a firm that specializes in physical and occupational therapy for assembly line workers, a producer and distributor of pallets, and industrial vehicle leasing and service establishments were surveyed, but bail bondsmen, convenience marts, and laundromats were not. Firms that primarily serve a household or individual market were excluded from the research for two reasons. First, the research is designed to maximize the data concerning firms that contribute to the “multiplier effect” of a local economy. The multiplier effect refers to “the expansion of the industrial or employment base from the recirculation of money, wages, and income” (Fik 2000, 51). Participant selection focused on those firms with the greatest likelihood of influencing the local *industrial* multiplier effect. In other words, firms that are most likely to employ other firms, and spawn a greater volume of higher paying jobs than those that employ minimum wage workers. Firms that primarily service households or individuals do not generate the same economic multipliers. For example, a bail bondsman, laundromat, or a convenience mart does not generate the same number or quality of employment opportunities as a manufacturer or a firm that leases and services tractor-trailer rigs. The manufacturer requires larger numbers of workers than convenience marts, laundromats, or bail bondsmen, and a percentage of the jobs will require skills above the minimum standard. This allows more citizens in the region to obtain benefits or some degree of disposable income that can be recirculated within the local economy. In addition, the manufacturer requires support services (such as leasing and maintenance of tractor trailer rigs) that likewise require semiskilled or skilled labor. This increases further the number of local workers able to obtain wages and/or benefits that can be recirculated within the local economy. The number of support

industries and the associated employment levels for those firms that market to individuals or households is fewer than those seen with manufacturers.

Secondly, firms that market to households or individuals have a greater potential to reflect the “economic boom” of reconstruction efforts after a disaster (West & Lenze 1994). This is particularly true of firms that provide goods or services that are in high demand after a disaster, such as construction firms and auto repair specialists. Since the research is intended to examine how a firm responds to a sudden exogenous shock to its operations, those firms that actually enjoy an “unnatural” increase in business due to the disaster were excluded from the research.

Because of time and budget constraints, all but two establishments in the industrial district that met the above criteria were visited. Six firms that had been visited declined to participate; of those that declined to participate two of them stated that there was “no point in it,” as they had not suffered any physical damage from the hurricane or the flood. Another two had not been in operation when Floyd struck. A fifth declined to participate because the firm had changed ownership and staff in the months before the research was conducted, and no one at the establishment could answer the questions on the survey. The sixth firm did not give a reason.

At each enterprise visited, the researcher asked to meet with the owner or general manager if it was an operation with few employees. If the establishment had a large number of employees, then a meeting with the Human Resources Director or similar senior manager was requested. Approximately 60 establishments were visited, but at roughly 30 of them a meeting time could not be established. In all but nine cases, a copy of the survey was left to be completed at the respondent’s leisure and either picked up by

the researcher, or mailed in by the respondent. In three instances the respondent was asked to submit the questionnaire to the establishment's home office (in two cases the home office was in another state). This was not done as the researcher felt that the respondent at the home office would not be able to answer several of the questions on the survey (such as the distance to the nearest natural hazard, or the number of hurricanes weathered by the establishment).

As part of the approval by the University of Florida's Institutional Review Board, the research protocol stipulates that the identity of the respondents remain anonymous. In addition, it also allowed respondents to refrain from participating altogether, to terminate their participation at any time, and to refuse to answer any question that the participant did not wish to answer. Of the 41 usable survey responses, 5 were mailed in and 13 were picked up. Respondents completed the remaining 23 surveys while the researcher was present. Of these 23, nine were completed by women, and 14 by men. Small and large firms were more likely to complete the survey with the researcher present. Medium-sized firms were more likely to take the questionnaire home or opt out of participating. It is possible that the medium-sized firms lacked enough management availability to accommodate the short disruption that the survey represented. Small firms, on the other hand, were supportive of the research effort and appreciated being asked to participate. Large firms were more cautious in their support, but provided more detailed information, once they reviewed the survey instrument and discovered that no proprietary information was being requested. Large firms were also more likely to request a copy of the survey results.

Generally speaking, almost all of the small firms participated in an interview. The small firms tended to be owner-operated, or they have a single manager in charge. This manager is often the general manager or the regional director. The small firm, in this case, is part of a larger corporate entity; a few reported that they were franchises, and one is a subsidiary. Similarly, almost all of the large firms participated in an interview too. In each case, the Director of Human Resources at the large firm was the respondent and interviewee. These establishments are either branch plants or independent operations. Medium-sized firms, on the other hand, were less likely to participate in an interview. These facilities appeared to have at least one employee with some supervisory authority, such as a foreman. However, the foreman (or other subordinate supervisor) was not the appropriate person to complete the questionnaire, as the owner or general manager never requested that this person complete the survey. Because these firms with limited managerial staff (e.g., foremen) were often unable to be interviewed, the results in Chapter 9 are limited in their interpretation.

Sitting with the respondent while the survey was completed allowed for an informal, open-ended interview to take place. Thus the survey method is best described as “supervised, self-administered.” Some of these interviews were less than 20 minutes, and a few extended to 90 minutes. The average length of time was 30 minutes. Several of the interviewees shared the experiences of the firm, the staff, and the personal accounts of neighbors, business colleagues, and others. Quick notes were made during these interviews, and then supplemental notes were made immediately after each interview was concluded. The data from the interviews is more qualitative in nature, and, for the most part, was analyzed separately from the survey data.

It is not always easy to determine the function of a business by its name or its exterior appearance. Consequently, nine of the survey results were not included in the research analysis. The researcher did not want to seem rude by abruptly terminating the survey's completion upon learning that the establishment did not meet the research criteria. For example, one establishment visited produced and distributed highly durable roofing material for mobile homes. This was not apparent from the name of the firm or the appearance of the establishment. Even the small entry foyer did not reveal the function of the firm. Not surprisingly, this particular firm had a tremendous upsurge in business after Hurricane Floyd. Therefore, the surveys from the nine inappropriate establishments are not included in the count of "completed" questionnaires for this research. The following table summarizes the reasons that firms were not included in this study.

Table 4—Reason Firm Not Included

Reason Not Included	# Firms
Researcher did not have enough time to visit firm	2
Firm declined: no damage suffered	2
Firm declined: not operating in 1999	2
Firm declined: changed staff & ownership since 1999	1
Firm declined: no reason given	1
Researcher asked to submit survey to distant home office	3
Survey completed by firm that did not meet participant criteria	9

In addition, three of the survey respondents had more than one facility in the proscribed research area. Two of the three had warehouse facilities that were located elsewhere in the study area separate from the headquarters and production facilities. The third establishment had colocated headquarters and research & development activities, but its manufacturing and logistics activities were each in separate locations within the study area.

Survey instrument

The actual survey questionnaire fit onto both sides of a single sheet of 11x14-inch paper. It was folded into thirds in an accordion style. This gave the survey the appearance of being a very small booklet that would require little time to complete. There are 29 questions on the survey instrument. All but eight of them are closed-ended questions; they can be answered by either circling the most appropriate answer or by entering a check mark into the appropriate box. The questions that could not be answered thus were open-ended. The open-ended questions solicit information such as the distance to the nearest natural hazard, and the number of days of business disruption caused by specific factors (such as road access or availability of staff). The final question was also open-ended; it asks the respondent's personal opinion of what he or she thought was the most important criteria for getting the establishment back to a 100% operational level.

A reformatted version of the questionnaire, designed to fit onto 8 ½ x 11-inch paper, is located in Appendix B. The questions on the reformatted version are in the exact same order as on the original version.

Problems with the survey instrument

As the research was being conducted, some problems with the survey instrument arose. Since not every respondent answered the questions in the presence of the researcher, these discrepancies were not resolved during the data collection process.

The wording of some questions was unclear or misleading, and in the case of Question 6, a poor choice of words rendered the question irrelevant. This question asked for the distance to the nearest natural hazard and gave "river, sound, ocean" as examples. Unfortunately, it did not give "creek" as an example as well. All of the respondents who

completed the survey in front of the researcher estimated their distance to the Tar River. However, for at least a dozen cases, a nearby creek was the source of flooding in that localized area. In addition, the question failed to consider the role that man-made structures can play in exacerbating or mitigating floods. Several establishments had drainage ditches or canals on site. A few even had retention ponds that normally fed into a nearby creek and ultimately into the Tar River. As these outlets flooded, the drainage backed up and caused the retention pond or canal to overtop its banks. This, in turn, flooded or threatened to flood nearby businesses. Consequently, this question was not used in the analysis.

In some cases, unclear wording of the question led to inconsistent responses. For example, when asked how many clients the respondent had gained or lost because of Hurricane Floyd (Questions 25 and 26), some respondents gave an exact number, some gave a range, and some a percentage. Others neglected to answer these questions. As a result, the number of responses to these questions is small, and they are not comparable; consequently, they could not be used in the analysis process.

Likewise, the wording was apparently unclear on Question 9, which asked if the firm had changed government jurisdictions when it relocated. Of the 14 respondents that relocated their operations temporarily, six did not indicate whether or not they moved into a location regulated by the county as opposed to their current location, which, for all intents and purposes, is regulated by the city. Therefore, since this question has so few useable responses, they are not numerous enough to use in the analysis without creating a bias in the statistical regressions (Greene 1999).

A final problem with the survey instrument is that the focus of the questions may not accurately capture the most critical elements of business disruption, response and restoration after a disaster. While the final question on the survey does attempt to address this concern, this difficulty can only be overcome by continued research into this field in order to establish a broad body of scientifically verified knowledge.

Coding of Data

The survey instrument offered dichotomous, continuous, and categorical variables for coding into the data set. For the dichotomous variables, 1 was used to indicate a negative response, and 2 was used to indicate a positive response. For the continuous variables, such as the number of days of business interruption that resulted from damage to various business elements (e.g., the firm's building or equipment), the exact number was entered into the data set. In cases where the number was given as a range (7-10 days), then the midpoint was entered. If the answer was written as a minimum (at least 30 days), or a maximum (not more than 60 days), then that amount was entered (30 and 60, respectively). There were two types of categorical variables on the survey. Most were rank ordered categories that followed a 1-to-5 scale, and were coded using these numbers. For instance, all of the questions that asked about the extent or degree of disruption suffered after Floyd were on the following scale:

1. No disruption
2. Minor disruption
3. Moderate disruption
4. Severe disruption
5. Extreme disruption

Some categorical variables were ranked on a 1-to-3 scale, such as the answers written down for the last question, which asks what the respondent feels are the most

important factors for getting back to normal operations after Hurricane Floyd. When coding the responses, it was assumed that the items listed were not of equal weight or importance. It was assumed that the first item listed was of greatest importance, and it was therefore coded as the First Priority. The next item listed was coded as Second Priority. There were very few responses listing a third priority (only three), and none reported a fourth.

The remaining categorical variables were not ranked in any order. For example, Question 10 asks about nine factors that may have discouraged the respondent's firm from relocating after Floyd. The responses to each variable were coded as dichotomous responses, with 1 for a negative response, and 2 for a positive. In those cases where a respondent did not answer a question, the cell in the computerized data set was left blank.

Although many of the variables in the survey instrument are quantitative, the interview itself allowed for the collection of qualitative data as well. During the interview handwritten notes were made, which were later examined and coded. Each set of interview notes was carefully examined in order to discover any trends or patterns in responses. One variable, the Degree of Flood Damage Sustained (Flooddmg), did lend itself to coding in the data set. Twenty-eight of the interviewees reported on the degree of flooding that occurred at their site. For those that suffered any flooding at all, it was remarked on early in the interview. This information was coded on a 1-to-5 point scale:

- 1 if no indication of floodwaters on site
- 2 if only the property was flooded, with no damage to items located outside, such as vehicles or inventory in storage yard
- 3 if the outside a storage yard was flooded enough to damage vehicles, equipment, supplies, and so forth, but no flooding of buildings occurred
- 4 if there was less than 1 foot of water in the building
- 5 if there was at least 1 foot or more water in the building.

In addition, a variable that indicated the level of management staff available at the establishment was also coded into the data set. The remaining qualitative response variables were then examined separately from the quantitative variables. This is in keeping with standard qualitative methods (Creswell 1994, 1998). The analysis of the qualitative variables provided a broader context for the research. It also provided a balance for the interview questions, as this type of disaster research has not previously been conducted. A complete listing of all of the variables used in this research is located in Appendix C.

Recoding of variables

Although 41 usable surveys were received, respondents were not required to respond to every question. Question 23 received the lowest number of responses: four. It asks if, after the flood, the location decision of major client's influenced the respondent's location decision. There were between 4-41 responses to the survey questions. Consequently, not all variables received enough responses to allow for a statistical analysis of them. This is particularly true for those questions that offered a choice from multiple possible answers. These multiple choices took one of two forms: an ordered ranking, or a listing of nonranked categories. For instance, a 1-to-5 ordered scale is used in all questions asking about the degree or extent of business disruption suffered. The scale ranges from no disruption to extreme disruption. However, not every category received five or more responses. This was true for all of the questions with rank-ordered variables. In each of these cases, the variables were recoded into dichotomous variables.

For all of the questions relating to the degree of business disruption, the answers were recoded in the following manner: 1 if the degree of disruption was reported as

None, Minor, or Moderate (1-3 on the original survey); 2 if the degree of disruption was reported as Severe or Extreme (4-5 on the original survey). Question 18 was similarly recoded, but not into a dichotomous response. This question offers five choices to describe the site's potential for expansion (Unsatisfactory, Poor, Adequate, Good, Excellent). Because the "Unsatisfactory" option had only one response, it was combined with "Poor" into a new variable (Figure 3).

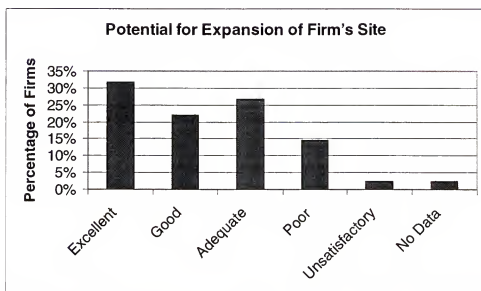


Figure 3—Potential for Expansion of Firm's Site

As for nonranked categorical variables, recoding involved grouping together those variables with low response rates that had some logical reason for being clustered together. For example, Question 10 offers nine possible nonranked categories for respondents to select when indicating what discouraged their relocation after Hurricane Floyd. The majority of respondents chose None. Seven of the remaining categories were regrouped into three new variables (Table 5).

Table 5—Regrouping of Seven Response Categories to Survey Question 10

New Variable	Old Variables
LOCLECON (Local economy)	SUNKCOST, LOCALMKT(Local market), & LCLMATRL (Local material)
NOLCLECN (Not local economy)	NOLBRELS (Labor limitations elsewhere) & NOGDSITE (Lack of suitable site for relocating)
OTRRSN (Other reasons)	SOCTIES (Social ties) & “Other”

were grouped together. Those categories that reflected limitations within the geographic spectrum (lack of a suitable new location for the firm’s operations, or the labor limitations elsewhere) were similarly grouped together. Social Ties was grouped with the “Other” category as it did not clearly fit into either of the first two groups. The category of Business Ties had six responses and was not recoded because it is unknown whether or not the business ties are local.

Furthermore, this particular question allows each respondent to select more than one category when answering. During the recoding process, the new variables were checked to ensure that no duplication of responses occurred. For example, if a respondent reported that both labor limitations elsewhere and a lack of a suitable new location prevented his operation from relocating, it was recoded as a single “yes” response—not two.

The last question with recoded nominal categories was Question 21. Two of the response categories were combined: National and International Primary Market Area. They were combined because only one survey respondent reported having an International Primary Market.

In addition to the recoding of categorical variables, two continuous variables were also recoded. The variable Number of Employees was recoded into the variable FirmSize.

This is composed of three discrete, ranked groups in order to allow comparisons to be made between this data set and the results published by FEMA (2000) and Wilson *et al.* (1999). Three categories of firm size were used in the two studies: Small (1-9 employees), Medium (10-99), and Large (100+). A new variable, “Relocate,” is a dichotomous variable that indicates whether or not a respondent relocated any portion of its activities either temporarily or permanently. This question is implied in the survey questionnaire, rather than asked outright. The survey asks for the number of days a firm relocated any part of its operations. Any respondent that indicated a duration for relocation was coded as a “yes” for relocation under the Relocate variable. A complete list of the variables that were recoded can be found in Appendix D. However, not all variables that presented difficulties in the preliminary analysis could be recoded.

Problematic variables that could not be recoded

Problematic variables were those that had fewer than five responses, yet did not lend themselves to recoding, and those with no responses at all. There are three general reasons why some variables with an inordinately small number of responses could not be recoded into another variable:

- The logical combination of variables still would not produce a minimum of five responses
- The variables with a low response rate do not lend themselves to recoding into another variable
- The different variables are answered by the same respondent(s); thus, combining them duplicates, rather than collates, their replies.

Question 5 on the survey provides an example of the first type of recoding problem. The question asks about the establishment’s operation type (Independent, Franchise, Branch Plant, Subsidiary, Other). Most of the respondents are either independent or branch plant

operations. Each of the remaining categories has fewer than five responses. They are too few to be utilized with confidence in a statistical analysis (Miles & Shevlin 2001). While one might recode the other three types into a single category, this was not done in this case, as the sum of the three variables' responses still tallied fewer than five (Figure 4).

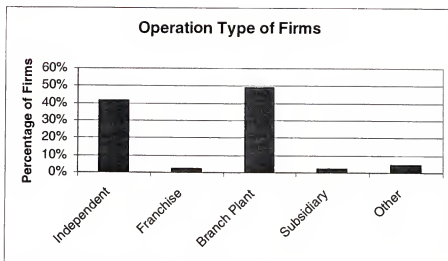


Figure 4—Operational Type of Respondent's Firm

The second type of difficulty encountered while recoding variables was that of variables that do not lend themselves to being grouped or clustered with another variable. This is the case with Question 23. This question is a dichotomous (yes/no) question that asks whether any business clients' decisions to relocate or remain influenced the respondent's location decisions. A second part of the question applies to those who responded yes to the initial question. The follow-up question asks for the approximate number of clients that influenced the respondent. Only four respondents answered this two-part question at all, and only three answered both parts. There are no other questions on the survey that are similar in nature to this question. Therefore there are no other variables with which this can be recoded.

A slightly different problem occurred with several of the “disaster experience” variables. Many of the options provided under Questions 1 and 7 had very few responses. Unfortunately, these responses are not suitable for combining into a new variable because the same few respondents were the only ones to select these options. Combining them would simply duplicate their responses. As a result, only the number of hurricanes experienced was kept as a variable for Question 1, and only three categories were kept from Question 7 (flood damage to headquarters, flood damage to logistics, and flood damage to manufacturing). Omitting variables from the data analysis was not only done under the circumstances listed above.

There are two other reasons for removing variables from the analysis, in addition to removing those that had fewer than five responses, and that were not able to be combined into another variable. Those variables that had no responses whatsoever were omitted from the data analysis. Similarly, those variables associated with Question 6 were also omitted from the analysis, as the question was poorly worded. As discussed in an earlier section of this chapter, Question 6 asks for the approximate distance to the nearest natural hazard. This was a poorly designed question because it fails to consider the impact of canals, flood retention ponds, and other man-made hazards. The question also fails to include the word “creek” in its list of examples of a natural hazard. As a result, everyone estimated the distance between their site and the Tar River; many completely ignored the source of localized flooding on or adjacent to their property: a creek, a canal, or a retention pond. A complete listing of the variables that were not used in the analysis is provided in Appendix E.

Data Analysis

Three types of analysis were conducted as part of this research. The qualitative interview data were analyzed in search of trends, patterns, and other relevant contextual information. One result of this analysis was the inclusion of two interview variables into the data set, as mentioned above. Next, the quantitative data were analyzed. This first involved a comparative analysis using Microsoft Excel '97. This comparative analysis focuses on the relational attributes of the responses. For example, a breakdown of the variables by respondent's industry type (such as manufacturing, wholesale, or transportation and warehousing) is a form of comparative analysis. The data were later analyzed using the software program SPSS (version 10.0). This second, more quantitative, analysis was performed after all of the recoding of the variables had taken place.

Given the exploratory nature of this research, much of the study involves the assessment of data. There are no published previous studies to provide guidance as to which variables should be included or excluded from postdisaster business studies. A concern with this research is that the variables obtained during the survey and interview processes may be so closely related that they only act to muddy the waters of the results. A correlation between variables means that, to some extent, the variables "explain" each other. If two or more variables correlate, then there is uncertainty as to which of the variables are important. As Miles and Shevlin (2001, 126) state: "when two variables covary (change together) we cannot decide which is important in determining the outcome." Furthermore, "if the variables are highly correlated, this implies that they are measuring similar constructs and that the information in one of those variables may be, at least partially, redundant" (Miles & Shevlin 2001, 131).

The statistical analysis used in this research was to test for the presence of a relationship between pairs of variables. This was accomplished by performing a chi-squared test for independence. Such tests “indicate the degree of evidence for an association” between variables (Agresti 1996, 33). It is possible with sensitive chi-square tests to examine general trends among variables. This examination focuses “on how the proportion classified in a given response category of *Y* varies across the level of *X*” (Agresti 1996, 38). Because much of the data is ordinal (rank ordered categories), Kendall’s Tau-B was used as a nonparametric test of association.

Notes

¹ The displaced may permanently relocate either voluntarily or involuntarily. The voluntary will often draw on financial resources, such as an insurance settlement, in order to begin anew elsewhere. The involuntarily resettled may not have a financial safety net, such as insurance, to help them during the aftermath. Or they may be forced to move because of regulatory changes that prohibit them from rebuilding their home at the original site. A third possibility is if a landlord is unwilling or unable to repair the residences he had been renting before the disaster.

² The “Buy-Out” program provides federal money for the purchase of residences in a floodplain that have suffered repeated flooding. It is also eligible for use to purchase severely damaged homes that have only been flooded once, but due to changes in the floodplain, may suffer a second flooding at some point in the future.

CHAPTER 5 THE LAY OF THE LAND IN NORTH CAROLINA

This chapter discusses both the topographic layout of the state, and the alteration of this landscape through the influences of development in eastern North Carolina. Together these two elements lay the groundwork for a complete explanation of the severity of the flooding that affected North Carolina in 1999. The following chapter details the meteorological events that contributed to the disastrous flooding of 1999. Chapter 7 finishes up the explanation of the factors that contributed to the severity of the 1999 floods in the state by discussing the combination of changes to the agricultural industry, and the region's transition from a rural to a more urban landscape. All of these factors contributed in their own way to the devastation suffered after Hurricane Floyd struck. Technically, the flooding was precipitated by a series of meteorological events. Yet the degree of flooding experienced by North Carolinians is a direct result of both the topography of the state, and the changes wrought on the landscape due to the transformation of the countryside by expanding human settlements.

Topographic Regions of North Carolina

Situated well north on the southeastern U.S. seaboard, North Carolina crouches like an outfielder with its glove of barrier islands ready to catch whatever the Gulf Stream and the Tropics throw its way. As a result, North Carolina's nickname is "Hurricane Alley". It covers 52,669 square miles (84,763 sq km), of which 3826 square miles (6157

sq km) are, in fact, inland water (SLNC 2001). The state's topography has three distinct regions: the Appalachian (Blue Ridge) Mountains, the Piedmont Plateau, and the Coastal Plain (Figure 5). Each region will be presented separately.

Appalachian Mountains

The Appalachian mountain range stretches along almost the entire eastern U.S. coastline. Over 300 million years ago, when the continents were united into a super-continent (Pangea), the Appalachians were part of a mountain range that included the present-day Atlas Mountains of NW Africa (Christopherson 2001). In the U.S., the Appalachians are composed of multiple smaller mountain ranges. As they pass through the mid-Atlantic and southeastern states, they are frequently referred to as the Blue Ridge Mountains. The Blue Ridge has some of the highest elevations within the Appalachian Mountain system. Within North Carolina, these mountains are typically 5000-6000 feet (1524-1829 m) in elevation. The Blue Ridge Mountains of North Carolina are a cluster of mountain ridges, basins, and valleys that run about 200 miles (322 km) in length, and extend out 15-55 miles (24-80 km) in width. The Great Smoky Mountains make up the dominant range of the North Carolina Blue Ridge, extending along its western edge. The Smokies have several peaks that exceed 6000 feet (1829 m). However, the highest peak in North Carolina is found in the eastern side of the Blue Ridge—Mt. Mitchell (6684 feet, or 2037 meters). The mountainous Blue Ridge province comprises only about 10 percent of North Carolina's area (SLNC 1999, NCDENR 2001).

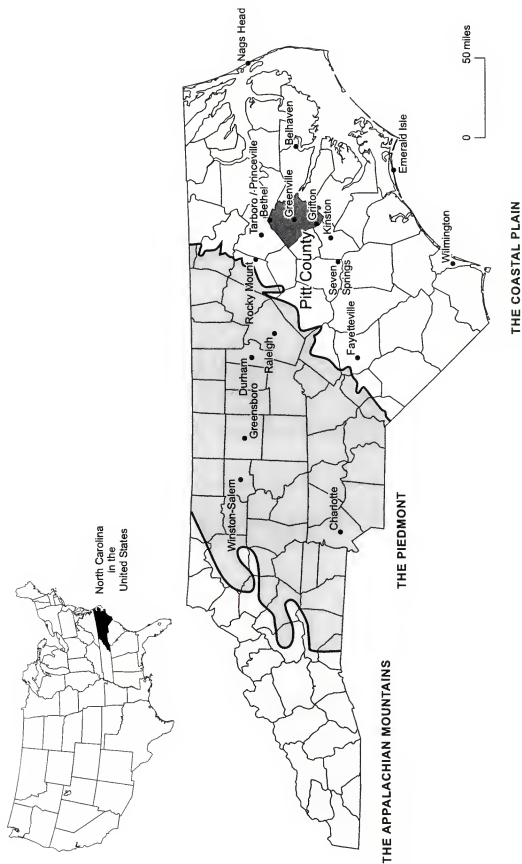


Figure 5—Topographic Regions in North Carolina

Piedmont Plateau

The Piedmont (which is French for “mountain’s foot”) makes up much of the center of North Carolina. From a topographic viewpoint, the Piedmont rests along the eastern side of the Blue Ridge. It serves as the initial deposition zone for the weathered and eroded material being carried downslope from the mountains to the ocean. The terrain elevations in the Piedmont along its eastern (Appalachian) flank are about 1500 feet (452 m) above sea level (NCDENR 2001, USGS 1972). The topography of the Piedmont gradually descends via its rolling, rounded hills, its long, low ridges, and its valleys, until it reaches the Coastal Plain. Along the “boundary” with the Coastal Plain the Piedmont elevations tend to range between 300-600 feet (91-183 m) above sea level (NCDENR 2001, USGS 1972). While there are some relatively low mountains, such as the Uwharrie Mountains, in the Piedmont Plateau, it is better characterized by the relatively modest differences in elevation between the hills and valleys of this area.

Almost half of the state falls within the Piedmont, and the state’s six largest cities (Charlotte, Durham, Fayetteville, Greensboro, Raleigh, and Winston-Salem) are located here (Census 2001c). Likewise, a substantial amount of the state’s manufacturing occurs here as well (SLNC 1999). This is not to say that farming does not occur here, as it is almost ubiquitous in North Carolina. On the other hand, a significant amount of manufacturing and farming occurs in the Coastal Plain as well. Indeed, the Coastal Plain has seen many of its numerous farms diversify into commercial (large-scale) hog and poultry production in recent decades (Hart & Chestang 1996).

Coastal Plain

Generally speaking, the eastern third of the state is the topographic area called the Coastal Plain. Hillsides are fewer and less distinct, and sharp areas of relief such as cliffs are seldom seen, except infrequently as erosional features along riverbanks (USGS 1972). Thus, much of the area is somewhat flat land with little or no topographic relief. For example, while Pitt County rests about 67 feet (20 m) above sea level (NCDENR 2001), the typical difference in elevation in Pitt County between naturally occurring high and low points is less than 5 feet (1.5 m) (USGS 1981a, b, c, d). The eastern portion of the Coastal Plain is the meeting point for nine of the state's drainage basins. These eastern-flowing basins converge within Pamlico Sound, due to the barrier created by the Outer Banks—a string of barrier islands that restrict the flow of water between North Carolina's rivers and the Atlantic (Figure 6).

Drainage Basins

Gravity is the operational force behind drainage basins. Surface water will flow across land from higher elevations to lower, until it eventually reaches sea level and open water (such as an ocean, sea, sound, or gulf). The main transportation route for surface water flow is rivers and their tributaries. The day-to-day flow of water is carried within the banks of the main channels (or main rivers) of a drainage basin. Nestled among these waterways are areas of low-lying ground: the floodplains. During small storms (or the rainy season) any increased water volume will flow into and along the primary floodplain. Often the primary floodplain will contain wetlands. These wetlands act as a “filtering sponge.” They help cleanse the water of sediments and particulate matter, as well as absorb and hold water for slower release into the main channel. Wetlands allow

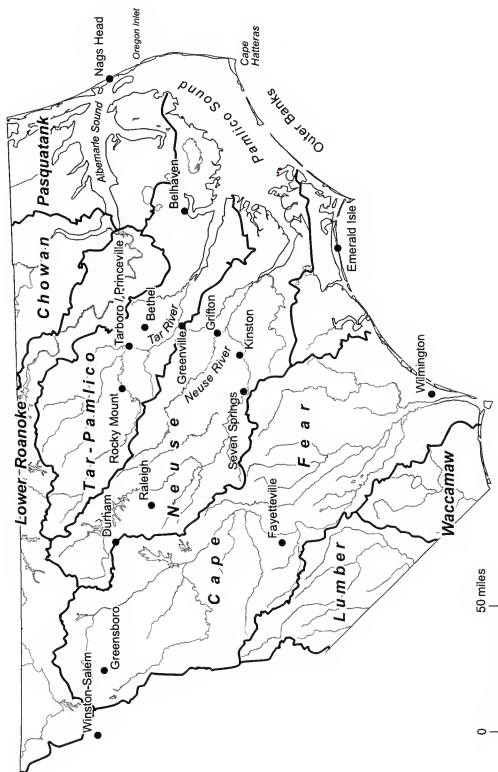


Figure 6—Eastern North Carolina's Major Drainage Basins

for a more uniform flow of water throughout the year (Riggs 2000).

A river will “reoccupy” a secondary floodplain when forced to carry substantially larger or prolonged volumes of water. Secondary floodplains tend to be used infrequently, and may not have wetlands. Both primary and secondary floodplains are of marginal quality or security for human development projects. Yet development has (and still does) occur within their boundaries (FEMA 1987, Mallin 2000, Riggs 2000, USACE 1998, Wood 2000). Of North Carolina’s 17 drainage basins, nine of them extend across the central and eastern regions of the state. For centuries, these fluvial arteries of water molded and shaped the landscape of the Piedmont Plateau and the Coastal Plain. According to the USGS (Bales, Oblinger, & Sallenger 2000), six of these drainage basins carry the majority of stream flow that crosses eastern North Carolina. They are listed in north-to-south order:

- The Chowan Basin
- The Pasquotank Basin
- The (Lower) Roanoke Basin
- The Tar-Pamlico Basin
- The Neuse Basin
- The Cape Fear Basin

Each of these major drainage basins flows in a roughly parallel, northwest-to-southeast direction. The Chowan and Pasquotank Basins begin in southeastern Virginia, but extend into northeastern North Carolina before entering Albemarle Sound. Likewise, the Roanoke basin also feeds into Albemarle Sound. The Roanoke extends across much of the boundary between North Carolina and Virginia, but the Lower portion of the Roanoke River Basin dips between the Chowan and the Tar-Pamlico basins. The Tar-Pamlico and Neuse Basins cover much of the heart of eastern North Carolina. They suffered the worst of the flooding in 1999; their outlet is the Pamlico Sound. The Cape

Fear Basin is not as densely covered with tributaries as the Neuse or Tar-Pamlico. The Cape Fear Basin releases its water near Wilmington, along the southeastern edge of the North Carolina coast (Bales, Oblinger & Sallenger 2000).

Barrier Islands and the Sounds

The Outer Banks are a chain of barrier islands that prevent water exiting North Carolina's drainage basins from flowing directly into the Atlantic. There are a few small inlets along the central and southern stretches of the Outer Banks where this exchange can occur. Otherwise, the stream flow passing out of the drainage basins pools behind the barrier islands. This "protected" water is called the Pamlico Sound. The Albemarle Sound rests between the northernmost drainage basins of North Carolina: the Chowan and the Lower Roanoke. Stream flow into Albemarle Sound will eventually feed into Pamlico Sound, since there is no outlet to the Atlantic at the northernmost end of the Outer Banks (opposite the Albemarle Sound). Pamlico Sound is a somewhat shallow lagoonal estuary with an average depth of 16 feet (5 m) that covers an area of over 2000 square miles (3219 km) (Bales, Oblinger & Sallenger 2000). It receives runoff directly from the Neuse and Tar-Pamlico drainage basins.

Scientists calculated that under normal circumstances, the entire Pamlico Sound drainage basin, including Albemarle Sound, could theoretically replace all of its freshwater every 11 months through runoff, rainfall, and related drainage flows (Bales, Oblinger & Sallenger 2000). Of course, the rates of drainage inflow, water circulation, and tidal behavior are not the same in all areas of the Pamlico Sound. As a result, the residence time of water within the Sound "is likely longer for many locations" (Bales, Oblinger & Sallenger 2000, 20). In fact, "long water residence times, small tidal

amplitude (1.0-1.5 feet) [0.30-0.46m], and slow flowing tributaries make Pamlico Sound an effective trap for dissolved and particulate matter” (Bales, Oblinger & Sallenger 2000, 20).

It is this “trap” function that allows the Pamlico Sound to serve as an excellent habitat for a variety of aquatic species. Unfortunately, the Sound’s ability to trap inflowing water created a major ecological hazard when the polluted floodwaters created by the rains of Hurricane Floyd started flowing in. Typically, the Neuse and Tar-Pamlico River Basins only contribute 31% of the inflow to the Pamlico Sound. However, during September 1999, this increased to 44%, and during October 1999, to more than 50%. More importantly, both of these river basins flow directly into the sound, and they “are known to carry relatively high loads of nutrients and other contaminants” (Bales, Oblinger & Sallenger 2000, 21). In addition, these floodwaters were reaching the Sound much faster than river waters do under normal circumstances. For example, it is estimated that the residence time for water in the Pamlico River and the Neuse River decreased from 72 and 68 days, respectively, to only 7 days by October, 1999 (Bales, Oblinger & Sallenger 2000). So any biochemical transformation or deposition of suspended material in these river waters did not occur before they reached Pamlico Sound. As a result, essentially all of the sediments, nutrients, and pollutants were arriving “en masse” at the Sound.

Water quality assessments of the sound included numerous tests for a variety of damaging substances, and for changes in the characteristics of the aquatic environment. The water samples were analyzed to determine levels of nutrients, pesticides, pathogens, metals, salinity, water temperature, pH, and dissolved oxygen concentration. The nutrient

and dissolved oxygen concentration levels help determine the likelihood of eutrophication and subsequent fish kills occurring. Nutrient levels (levels of nitrogen and phosphorus) can also help predict the extent of destructive algal blooms that may occur. And even somewhat minor changes in salinity or temperature can suddenly kill off shellfish and some finfish species.

Contamination by pesticides, metals, and high organic sediment loads not only jeopardizes aquatic species, but presents serious health hazards to humans as well. Property (such as homes, businesses, and cars) can be transformed into a serious health risk due to contamination by floodwaters. For example, toxic mold spores carried in the floodwaters can reproduce on the walls, ceilings, and floors of buildings once the floodwaters recede. Contact with fecal material that was transported and deposited in human living areas can also present health hazards. Likewise, consumption of seafood taken from contaminated sources also poses a serious health risk to humans. To ascertain the risk to human health, samples of floodwaters were gathered across the affected regions of the state during the duration of the flood event. These samples were tested for the presence of over 40 pesticides, more than a dozen metals or related chemicals (including copper, lead, mercury, and arsenic), and several pathogens (Bales, Oblinger & Sallenger 2000; Mallin 2000). The presence of pathogens serves as an indicator of fecal contamination of water. Given that both human wastewater facilities and hog wastewater lagoons were releasing material into the floodway, fecal contamination was a genuine concern. Exposure to fecal material can result in a variety of illnesses, including cholera, dysentery and hepatitis (CDC 2001, Mallin 2000).

Water samples were examined for both bacterial and protozoan pathogens. Three bacterial pathogens found in the floodwaters were *Escherichia coli* (*E. coli*), *Clostridium perfringens* (*C. perfringens*), and fecal streptococci. Also found were the protozoans *Cryptosporidium* and *Giardia lamblia*. All of these pathogens are indicators of fecal contamination. These pathogens were being transported and deposited by the floodwaters of Hurricane Floyd in extraordinarily high amounts in various locations in eastern North Carolina (Bales, Oblinger & Sallenger 2000).

Determinations needed to be made regarding the direct and indirect health risk posed to humans by the floodwaters and the Pamlico Sound. Direct risks were severe, due to the highly polluted nature of the floodwaters. Contamination by human and hog waste created a serious health risk by themselves. But Floyd added to it a large number of other pollutants as well. The extraordinary pollution levels resulted in a health advisory for people to avoid having their eyes, ears, noses, mouths, or any cuts or sores come into contact with the floodwaters (Stephenson 2000). In fact, exposure to the polluted runoff just offshore from the Outer Banks town of Emerald Isle caused six surfers to become ill (Stephenson 2000). In addition, the state mandated a prohibition on harvesting any form of seafood from the waters of the Pamlico Sound and the nearshore coastal areas of the Outer Banks for some time after Floyd (Crowder & Miller 2000, Gilbert 2000). Harvest of seafood from these areas is for household consumption and income production on either the formal or informal economy. Closure of these waters to harvest was a necessary safety measure; it was also a hard blow to those who subsidize their food bills with seafood harvesting.

On the Outer Banks, the greatest hazard to residents was dune movement or destruction. This is often the greatest cause for concern, as it represents the barrier island's ability to weather future severe storms, in addition to the general destructive capacity of dune movement itself (FEMA 1987). Not surprisingly, it was Dennis' prolonged spell just offshore from the barrier islands that caused the most severe damage to the dunes and beaches of the Outer Banks. Hurricane Floyd plunged inland shortly after reaching the North Carolina area, and Hurricane Irene maintained a steady northerly movement as she passed along the North Carolina coast. Individually, the damage to the Outer Banks caused by Floyd and Irene was not as destructive as that caused by Dennis (Bales, Oblinger & Sallenger 2000).

The dunes of the Outer Banks protect the barrier islands from storm erosion and wave overwash. Dune erosion from Dennis was highly variable. The northern area of the Outer Banks, from Cape Hatteras to Oregon Inlet, was particularly hard hit. Within this area some dunes retreated over 100 feet (30 m), and yet were stable elsewhere. Additionally, dune erosion in one area led to the destruction or condemnation of several ocean front homes (Bales, Oblinger & Sallenger 2000). While Floyd's impact on the coastal communities was not as catastrophic as residents had feared, there was still a lot of rebuilding necessary afterwards (Altman 2000, Pilkey & Stutz 2000). For those who view their vulnerable coastal property as an investment, a recent study seems to indicate that repetitive hurricane events have only a short-term effect on property values. This may, of course, be due to a variety of mitigating factors, such as a continuing immigration of increasingly affluent people, a strong economy, and limitations on residential construction in coastal areas (Graham & Hall 2001).

While this chapter has presented some of the effects of Floyd in terms of the landscape of the state, the following chapter discusses the meteorological events in the summer and autumn of 1999. This includes the deadliest storm to hit North Carolina in the twentieth century: Hurricane Floyd.

CHAPTER 6 HURRICANE ALLEY

This chapter describes the general characteristics of hurricanes, and the three hurricanes that collectively created the flooding disaster of 1999 in North Carolina: Hurricanes Dennis, Floyd, and Irene. Each is discussed individually in subsections of this chapter. Given that Floyd was by far the largest and most destructive of the three storm systems, more information is presented in regards to that particular hurricane. However, these storms were not the only ones to hammer the state. North Carolina has a long and somewhat dubious distinction of being a “target” of such storms. Figure 7 depicts the number of landfalling hurricanes or tropical storms in North Carolina during 1899-1999. It does not depict tropical depressions that made landfall in the state during this time. As a result, Hurricane Dennis does not appear under the entry for 1999, as the storm had downgraded to tropical depression status before making landfall.

General Characteristics of Hurricanes

The most meteorologically powerful of tropical cyclones, hurricanes are composed of three distinct parts: the eye, the eyewall, and the outer rainbands. Air within a hurricane spirals inward (in a counterclockwise direction) towards the center; once at the center the air falls, creating the eye.¹ The eye is a place of distinctively clear skies where the storm’s fierce winds are becalmed. The eye can stretch in diameter from 20-40

miles (32-64 km). As the hurricane's eye passes over an area, people invariably remember the abrupt change from wind and rain to calm. As the storm continues to

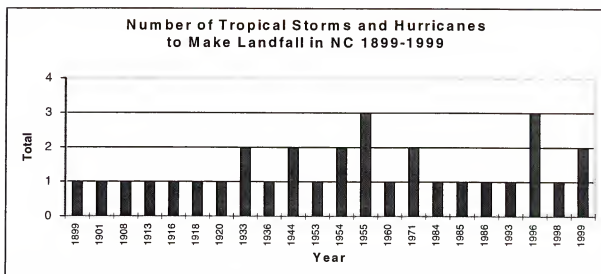


Figure 7—Number of Tropical Storms and Hurricanes to Make Landfall in NC 1899-1999

Source: Bales, Oblinger & Sallenger 2000, NCDC 2001, Stephenson 2000.

Note: Years missing in the graph had no landfalling tropical storms or hurricanes.

move, the eyewall passes, just as quickly changing the weather back to that of the storm's intensity. However, when the eye departs, the winds return – this time flowing in the opposite direction.

The eyewall refers to that portion of the hurricane that encircles and defines the eye of the storm. The eyewall is, in fact, a "wall" of densely packed thunderstorms that are moving in a counterclockwise direction around the eye of the hurricane. Within the eyewall are the strongest and most severe of windspeeds within the storm system. Any changes in the makeup of the eyewall (its structure) can result in changes to the wind speed of the storm. Since the speed of the winds within the hurricane are central to maintaining the storm's intensity, changes in wind speed affect the overall strength of the

storm. These changes may result in an expansion or shrinking of the storm's eye or, in the case of extremely powerful hurricanes, the creation of a second (or concentric) eyewall.

Splaying outward from the eyewall of the hurricane are bands of high winds and rain. Depending on the geographic size of the storm, these outer rain bands can stretch outward hundreds of miles. The outer rainbands of an "average" hurricane extend across an area of up to 300 miles (483 km). These outer rainbands stretch anywhere from 50-300 miles (80-483 km) in length, and from a few miles to tens of miles in width. Individual rainbands are composed of dense thunderstorms and strong winds; winds within these bands may be of tropical storm or hurricane force—depending on the intensity of the hurricane. Given the swath of the rainbands, a hurricane can cause a lot of destruction to areas far from the eye of the storm.

The circulation of winds within a hurricane is in a counterclockwise direction. However, for the individual on the ground the wind direction varies depending on where the storm's eye is in relation to the individual. If the individual is above (north) of the eye, then the winds blow from east to west; if the individual is below (south) of the eye, then the winds flow westerly. Even though the air within a hurricane flows in a counterclockwise direction, the storm itself travels a path influenced by a variety of atmospheric traits, such as barometric pressure, wind shear, and the presence of high and low pressure cells. As a general rule, hurricanes travel at an average speed of 15-20 miles per hour (24-32 kph), although some were recorded moving with speeds up to 60 mph (97 kph). Hurricane Hazel was such a fast moving storm. On the morning of October 15, 1954, Hazel hit North Carolina. Fourteen hours later Hazel hit Toronto, Canada, killing 80 people (Christopherson 2001, NOAA 2001).

Hurricanes of 1999

Hurricane Alley is an apt nickname for a state that suffered through the landfalls of six tropical cyclones in just four short years. Tropical cyclones are meteorological events that are referred to as either a tropical depression, a tropical storm, or a hurricane. During this period, 1996-1999, four of the six tropical cyclones to make landfall in North Carolina did so as hurricanes (NCDC 2001).² These four hurricanes were Bertha and Fran (1996), Bonnie (1998) and Floyd (1999). Hurricane Dennis, which also came ashore in North Carolina in 1999, was a tropical storm at the time of landfall. (This is described in greater detail in a following subsection.)

For those individuals who moved to eastern or coastal areas in North Carolina in recent decades, the state's nickname may have seemed merely a quaint reminder of its distant past—not unlike the galleons sunken off the Outer Banks. After all, there were only seven tropical cyclones to come ashore in North Carolina during the entire preceding 40-year period (1956-1995) (Bales, Oblinger & Sallenger 2000; NCDC 2001; Stephenson 2000). Though the argument may be made that some portion of the population may have been lulled into a false sense of security because of the infrequency of hurricane landfalls after WWII, this probably is not true of all of them. The memories and stories of the devastation caused by Hurricane Hazel's arrival (in 1954) are still shared in North Carolina (Riggs 2000).

In addition, the false security argument fails to account for two other important considerations. First, numerous tropical cyclones made landfall elsewhere, yet carved a destructive path through North Carolina. For example, Hurricane Hugo made landfall in South Carolina in 1989, but still managed to pack a wallop when passing through North

Carolina during its northward trek (Barnes 2000, FEMA 1990). Secondly, tropical cyclones extend across a broad area, with their effects being felt hundreds of miles from their center (Beven 2001). Therefore, those tropical cyclones that remain offshore without ever making landfall can still create difficulties for coastal and inland areas. Countless storms tracked northward along the eastern seaboard without ever making landfall, yet they left destruction in their wake.

Although eastern North Carolina does seem to be an attractive target for tropical cyclones, this however, is not the only form of severe weather the area encounters. Snowstorms, tornadoes, and hail occur infrequently in eastern North Carolina as well. But one of the more destructive natural hazards to affect the state is much slower in its onset, and far longer in its duration—drought. The onset and endpoint of a drought are so subtle, they are practically impossible to predict. In fact, most of North Carolina was suffering from drought conditions in the summer of 1999 (Bales, Oblinger & Sallenger 2000; FEMA 2000b; Steelman 2000). Those unfortunate farmers who prayed for rain to ease the drought, had no way of knowing just how much rain they would end up receiving. First came Hurricane Dennis (Sept. 3-7, 1999); then a persistent cold front arrived bringing more wet weather with it. Between September 14-17, Floyd swept down upon this rainy front and consumed it. For a time, Floyd was a massive, meteorological monster. Then, just a few short weeks after Floyd's deluge Hurricane Irene breezed by (October 17-18). At the end of these seven weeks, Raleigh (which is well inland), received over 24 inches (61cm) of rain, coastal Wilmington over 27in (68cm), Greenville over 30in (76cm), and Rocky Mount almost 38in (97cm) of rain (Bales, Oblinger & Sallenger 2000).

These rainfall totals oversimplify a complex series of events, which, had they occurred individually rather than as a cluster, would not have been so devastating. By occurring in such quick succession, they created a catastrophe that residents of eastern North Carolina will never forget.

Hurricane Dennis

Dennis was no “ordinary” hurricane—his shape, path, and intensity were all erratic.³ His first trip along the North Carolina coast began on August 30. He stalled offshore, zig-zagging first towards and then away from the coastline until September 3. During this oscillating trajectory, Dennis’ intensity as a tropical cyclone fluctuated so much, that he was downgraded to tropical storm status, and then reclassified once again as a hurricane after a period of strengthening.⁴ However, Dennis degraded down to tropical depression strength just before his landfall on September 3. Dennis lingered over the eastern area of the state for the next 4 days, bringing much-needed rain to eastern and coastal North Carolina. In terms of duration as a storm system, it was not until 2 days after his departure from North Carolina on September 7, that Dennis ceased to be a tropical cyclone (Beven 2000). The initial good news from Dennis was that enough rain fell to saturate the dehydrated soils across the region. In fact, the Tar-Pamlico River Basin received much of Dennis’ rain: from 5 to 7.6in (13-19 cm) (Bales, Oblinger & Sallenger 2000). However, a frontal weather system arrived in eastern North Carolina right on the tail winds of Dennis, and carried along with the system were thunderstorms and more rain—rain that lasted for much of the following week (Beven 2001).

Hurricane Floyd

Of the three hurricanes to visit North Carolina during September and October 1999, Floyd was by far the most damaging. While the effects of the storm surge of 9-10 feet (2.7-3m) were not unexpected (Altman 2000; Bales, Oblinger & Sallenger 2000; Sparks 2000; Pasch, Kimberlain, & Stewart 2001), it was the rain, rather than the wind, that caused the greatest damage to eastern North Carolina as a region. Hurricane Floyd's intensity had diminished substantially by the time it made landfall on September 16. On September 13, Floyd was a gigantic hurricane whose estimated intensity almost reached Category 5 levels. The following day a second, or replacement eyewall formed, which often signals the diminishing intensity of a tropical cyclone; by the time of Floyd's landfall early on September 16, the storm had weakened considerably—down to a Category 2 hurricane (Pasch, Kimberlain, & Stewart 2001).

Yet there is far more to Floyd's impact on North Carolina than just this. While the eye of the storm was centered off of Florida's coast, the diameter of the entire cyclone that comprised Floyd was over 600 miles (965km) (BBC 1999). Typically, hurricanes stretch less than 300 miles (483km) across. But this is no indication of their intensity—in fact, the devastating Hurricane Andrew back in 1992 stretched only 100 miles (161 km) across (NOAA 2001). In other words, the outermost bands of clouds, wind and weather associated with Floyd were an extensive distance away from the eye of the storm. As a result, much of the southeastern seaboard of the U.S. felt the effects of Floyd long before he arrived. Additionally, these outer bands of Floyd brought both wind and rain to eastern North Carolina right on the heels of Dennis and the aforementioned cold front. But it was

the winds associated with Floyd that truly set the stage for the flooding that came afterwards.

Floyd's winds

Winds in a tropical cyclone in the Northern Hemisphere rotate in a counterclockwise direction (Christopherson 2001, NOAA 2001). Though the eye of the storm was still offshore (and indeed when it was still farther south, off the coasts of northern Florida, Georgia, and South Carolina), the winds blowing within the outermost bands of the storm, were already *blowing onshore* in the days before Floyd's landfall. These strong onshore winds (30 knots or more) (Pasch, Kimberlain, & Stewart 2001) acted like a plug in the drainage basins of eastern North Carolina. The onshore winds were blowing *stronger than normal tides into* the coastal areas, which prevented the excess precipitation that fell inland from flowing down the rivers, into the sounds, and out to sea (Bales, Oblinger & Sallenger 2000). This backup of the drainage basins left nowhere for the water to go to, except into buildings, farms, towns, and highways. Thus the prolonged, strong onshore winds of Hurricane Floyd greatly contributed to the severity of flooding within inland areas.

Although this "backwash" phenomenon can occur to a greater or lesser extent with the passage of any tropical cyclones, few references to the impacts of such events are reported in the literature. A noteworthy exception is Sebastian Junger's (1997) reference to the inland flooding that occurred in Albany, New York due to strong onshore winds associated with the passage of Hurricane Grace off of the New York coast in October, 1991. Dr. Caviedes, of the University of Florida, noted this phenomenon during Hurricane Floyd's passage along northern Florida's coastline.⁵ Figure 8, illustrates the

effect of Hurricane Floyd's counterclockwise winds on the drainage basins of eastern North Carolina.

Floyd's winds were estimated at 90 knots at landfall on September 16. This is quite a reduction from the maximum sustained winds of 135 knots reached on September 13. There are numerous reports of people "gearing up for the Big One" while preparing for Hurricane Floyd (see Rickert 2000). Much of the preparation was in anticipation of wind-related problems, including projectiles, wind-driven rain or storm surge—the extremely high waves pushed along by the force of the cyclonic winds (Christopherson 2001). Yet Floyd's winds proved to be somewhat "gentle" in terms of their destruction—particularly in light of public expectation of a higher intensity storm making landfall (Bales, Oblinger & Sallenger 2000; FEMA 2000b). For instance, quite a few respondents in Greenville reported after Floyd's passing that there was little or no damage to businesses or personal property observed in the area. The trees that fell did so because *the soil was too saturated to support the roots any longer*; the wind merely hastened their falling.⁶ At the time, these individuals simply considered themselves lucky, and went to work making plans to cut up and remove the fallen trees over the upcoming weekend. In fact, one respondent reported thinking: "We missed the bullet this time." In reality, though, the warning signs of the danger yet to come were all around them. Unfortunately, none of the residents had any experience with major inland floods, and therefore they could not recognize a warning in what they saw.

Floyd's tornadoes

It is not uncommon for hurricanes to spawn tornadoes. For example, dozens of tornadoes were spawned by Hurricane Camille when it came ashore in 1969

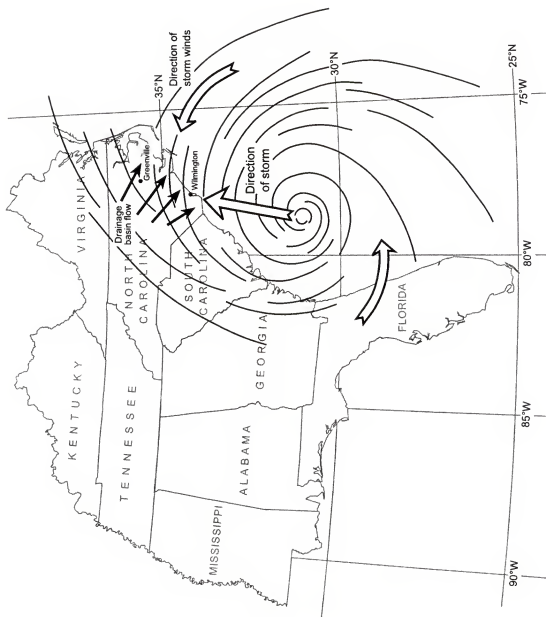


Figure 8—Effect of Hurricane Floyd's Counterclockwise Winds on Eastern North Carolina's Drainage Basins

(Christopherson 2001). As Hurricane Floyd came ashore a number of tornadoes or funnel clouds were reported along North Carolina's coastal area (Bales, Oblinger & Sallenger 2000). A few tornadoes caused structural damage, and one destroyed two homes. But the real danger from Floyd was the torrential rainfall landing on already saturated lands and already strained drainage systems.

Floyd's rains

As Floyd approached the state, the warm moist air on the northeast side of the cyclone preceded the heart of the hurricane into the state. This advancing warm air encountered the frontal weather system that had stalled over the state. The air associated with Floyd was warmer and more saturated with moisture than that of the frontal system. When warm air encounters cooler air, the warm air mass glides up and over the wedge of cooler air. It does so, because the warm air is less dense than the cooler air (Christopherson 2001). When this occurs, as in the case of Floyd, the tropical cyclone "overruns" the cooler air mass.

Because Floyd overran the frontal rains that had been falling on eastern North Carolina (Pasch, Kimberlain, & Stewart 2001), there is no explicitly drawn line between the two separate rain events. This is in part because as warm, moist air rises in the atmosphere (for instance, as it glides up over cooler air masses), the warm air cools, the moisture within it condenses, and results in rain (Christopherson 2001). In the days before Floyd's landfall, North Carolina experienced very heavy rainfall (Pasch, Kimberlain, & Stewart 2001). The U.S. Geological Survey reports that total rainfall amounts between September 14 and 17 (from when the advancing bands of Floyd encountered the stalled weather front over North Carolina, to when it passed from the

state) varied from roughly 5 to 20 inches (13-51cm) (Bales, Oblinger & Sallenger 2000). This variation is due in large part to the different storm tracks that Dennis and Floyd took. Figure 9 illustrates the variation in rainfall along the storm tracks of Hurricanes Dennis and Floyd as they crossed the state.

Floyd picked up speed as he sloshed ashore near Wilmington, with the storm's eye crossing the state in *less than 10 hours*. By midnight the eye of the fast-moving storm had reached Long Island (Pasch, Kimbrialin & Stewart 2001). Given the speed with which Floyd covered the state, it is remarkable how much rain was dropped in passing. Because Floyd's outermost rain bands reached the state and absorbed into them the existing rainy frontal weather, the rain totals for Floyd include the frontal rain that preceded the landfall of the hurricane's eye near Wilmington. The frontal weather notwithstanding, Floyd brought substantial rainfall within the massive thunderstorms swirling around its eye. As a result, Wilmington, received a little over 19in (48.5cm) of total rain from Floyd. As the storm curved towards Greenville he dropped 12.6in (32cm) of rain there. Its reach extended upriver towards Rocky Mount; Floyd drenched that city with 14-18in (35.6-45.7cm) of rain. Most, if not all, of this precipitation was *in excess of what the soil could absorb*, since the ground in much of eastern North Carolina was already saturated before Floyd arrived (Bales, Oblinger & Sallenger 2000). "Dry soil allows more infiltration of rainfall and less runoff, whereas wet soil results in more runoff for the same amount of rainfall" (Bales, Oblinger & Sallenger 2000, 10). Clearly, by the time Floyd arrived in North Carolina, the drought conditions had abated. The extraordinary amounts of rainfall contributed to the conditions in North Carolina that set the stage for the worst flooding ever recorded in the state (Table 6).

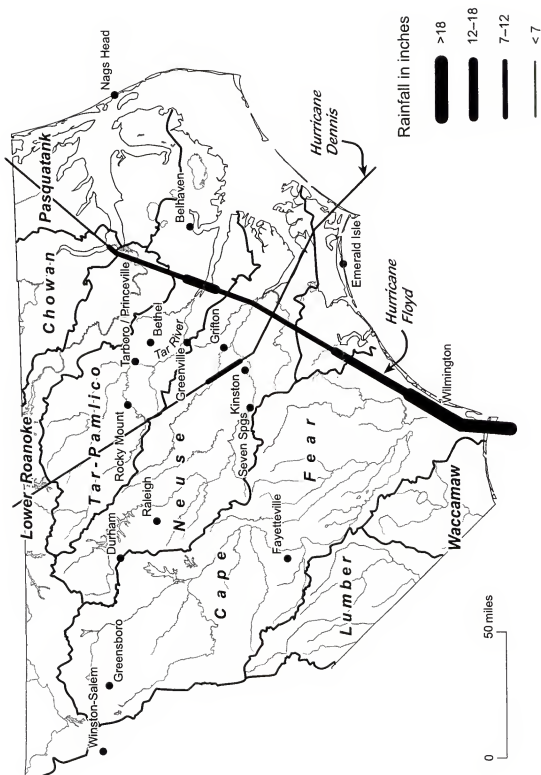


Figure 9—Rainfall over North Carolina by Hurricanes Floyd and Dennis, 1999

Table 6—Rainfall in Inches (Centimeters) from Hurricanes Dennis and Floyd in Three Eastern North Carolina Cities

Rain Event	Greenville Rain		Rocky Mount Rain		Wilmington Rain	
	in	cm	in	cm	in	cm
Dennis 9/3-7/99	7.0	17.8	*6.3	*15.0	0.6	1.5
Floyd 9/14-17/99	12.6	32.0	*16.0	*40.6	19.1	48.5
Sept-Oct '99 total	30.2	76.7	37.7	95.6	27.1	68.8
Annual average	49.0	124.5	44.2	112.3	54.3	137.9

Source: Bales, Oblinger & Salenger 2000

Note: * this figure is the median of the total range of reported rainfall for Rocky Mount for the given storm.

Normally this runoff would flow down through the drainage basins, into the Pamlico Sound, and eventually into the Atlantic. However, until the eye of Floyd passed, his counterclockwise winds were preventing the outflow of water from the sounds and basins. Consequently, the runoff from all of this rain was backing up the rivers and tributaries in coastal areas, and thus setting the stage for major flooding in the state's interior.

Floyd's flood event

A drought is considered a slow-onset disaster. Earthquakes are sudden-onset. Hurricanes and floods are somewhere in the middle. There is usually some advance warning, but not necessarily a lot of warning (Burton, Kates & White 1993). If the warning is given to a population with little or no experience with the disaster, then it may be discounted entirely. Or they simply may not know how to adequately prepare.

The people of North Carolina received plenty of warning about Hurricane Floyd (Pasch, Kimberlain, & Stewart 2001; McComas 2000). Although the eye came ashore at approximately 0600 on Friday, September 16, everyone I met in Greenville referred to Hurricane Floyd as having occurred Thursday night. This is no doubt due to Greenville's distance from the shore, and the severity of Floyd's advancing outer bands. On Friday

morning they woke, surveyed their surroundings for damage, noted what relatively little there was, and considered themselves lucky as they went to work as usual that Friday morning. Little did they know as they worked through Friday morning, that the swollen Tar River was bringing a colossal amount of water their way.

Though the residents had received hurricane warnings, none of the businesses interviewed in the large industrial area north of the Tar River on the outskirts of Greenville had received any official or media notice that the Tar River was flooding. In fact, during the study period, only two of the businesses visited had a radio playing. Assuming that this is typical, dissemination of flood warnings to workplaces could only have succeeded had they been conducted in person. Indeed, many of the businesses learned about the flooding bridges and road closures from their employees (such as delivery drivers), clients, or customers. Some had no “real” notice until the floodwaters began rising in their business’ driveways, storage yards, or parking lots. The limited advance warning of the impending flood is illustrated by reports from two separate respondents who had been advised: “Pick whatever side of the river you want to spend tonight on—and get there NOW.”

This was just the beginning. The river would keep rising throughout the weekend, and crest on Sunday afternoon. Then after the crest, came the slow days of waiting for the floodwaters to recede. During a flood event a river crests (or peaks) at different times in different places as the water flows downstream. By Saturday, eastern North Carolina began to wait and watch their fast-moving rivers (Tar, Neuse, Cape Fear, and others) as each systematically passed through their cresting flood stage at various towns and cities along their paths.

In some places the extent of the flooding was catastrophic. Completely submerged were the entire downtown areas of over 30 towns, hamlets, and crossroads communities in Eastern North Carolina, including the town of Princeville (McComas 2000). Where the Tar River passes between Tarboro and Princeville⁷, the river crested at 41.5 feet (12.6m) above flood state; this far exceeds any previously recorded maximum flood stage. Record-keeping of water levels of the Tar River at Princeville began in 1897 (Bales, Oblinger & Sallenger 2000; Riggs 2000). Additionally, the volume of water being carried on the Tar River at this point (the maximum flow) was *almost double* the previous recorded maximum flow set in 1940 (Bales, Oblinger & Sallenger 2000). By comparison, floods from the 1955 hurricane season, in which another three storms hammered the state in a six-week period⁸, resulted in a river crest of just 17 feet (5.2m). The flood of 1919 crested in Greenville at 24.5 feet (7.5m). Yet the floods from Floyd crested in Greenville at 29.74 feet (9.06m) (Figure 10) (Bizzaro 2000, Riggs 2000). Needless to say, floods from such an extraordinary volume of water requires days to recede. In fact, all of the people I met in Greenville agreed that it was basically a full week before the watery moat that transformed much of Greenville (and numerous smaller communities) into an island had finally dried up. Indeed, many North Carolinians were understandably concerned when notified a few weeks later that Hurricane Irene was heading their way.

Hurricane Irene

October 17-18, 1999, just as North Carolina finally began to dry out: along came Irene. The good news: she never made landfall in the state. The bad news: rainfall

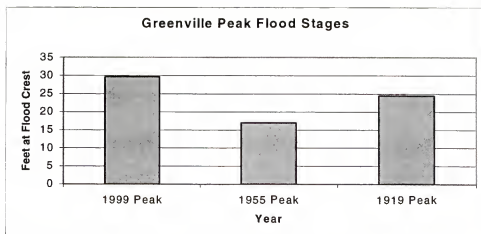


Figure 10—Peak Flood Levels in the Tar River at Greenville, NC

from Irene ensured that several rivers remained above flood stage in eastern North Carolina for several more weeks (Bales, Oblinger & Sallenger 2000; FEMA 2000b). Irene first took aim at the Florida Keys, but she got swept into the Gulf Stream, and made her only U.S. landfall near Cape Sable, Florida, on October 16 (Avila 2001). She then blew back out to sea, and proceeded to track northeast along the coast. Fortunately, she only brushed the Outer Banks of North Carolina as she passed by on the October 18. However, a hurricane covers a broad area, and Irene was no exception. Even though Irene did not tear through the interior of the state, the storm did bring another significant dose of rain to the area during the storm's northward trek (October 17-18, 1999). Although Raleigh received only 1.5 inches (3.8cm) (Irene's reach was not that extensive), Rocky Mount was once again soaked with over 5 inches (13 cm). Greenville fared a little better—the city received only 3.3 inches (8.4cm) (Bales, Oblinger & Sallenger 2000). Figure 11, below, compares the deluge that fell on three of eastern North Carolina's cities during this seven-week period with the previous flood peaks recorded by the USGS for those cities.

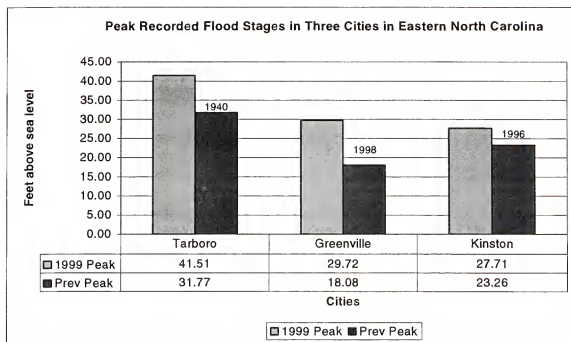


Figure 11—Peak Recorded Flood Stages in Three Cities in Eastern North Carolina

Dennis, Floyd, and Irene appeared on the North Carolina stage arm-in-arm, like members of a chorus line. During their seven-week run they brought unprecedented amounts of rain to some areas. In fact, most rainfall reporting stations within the eastern region of the state received half of their average annual rainfall during this one period. The city of Rocky Mount, located within the Tar-Pamlico River Basin, suffered the worst: it sopped up 85% of its average annual rainfall during September and October, 1999 (Bales, Oblinger & Sallenger 2000). These rainfall amounts are the immediate, meteorological effects of these dangerous storms. The human and ecological effects would last for months and years.

Notes

¹ Tropical cyclones in the Northern Hemisphere flow in a counterclockwise direction. Those in the Southern Hemisphere flow in a clockwise direction (Christopherson 2001).

² 1996: Hurricanes Bertha & Fran

1997: Hurricane Bonnie

1999: Hurricane Floyd

³ For more information on the unusual shape of Hurricane Dennis, please refer to Avila 2001.

⁴ A copy of the Saffir-Simpson Scale, used to categorize the strength of hurricanes (NHC 2001b) is located in Appendix A.

⁵ During my stay in Greenville, NC, in June, 2001, this phenomenon was described to me by a large number of residents in a variety of layman's terms. It was "common knowledge" within Greenville that it contributed to the severity of the flood there.

⁶ At the time of Floyd's landfall on September 16, 1999, areas in eastern North Carolina had been receiving rainfall for most or all of 17 consecutive days.

⁷ Princeville is one of the first African-American communities to incorporate in the U.S. It lies on the low side of the Tar River Basin, directly across from Tarboro. A levee built in the 1950s did not prevent Princeville from being completely submerged during the flood (FEMA 2000b).

⁸ The 1955 hurricane season brought ashore Hurricanes Connie, Diane, and Ione in North Carolina (Bales, Oblinger & Sallenger 2000, Barnes 2000, NCDC 2001).

CHAPTER 7

PEOPLE OF EASTERN NORTH CAROLINA

The Coastal Plain of North Carolina, roughly the eastern third of the state, is an area in the midst of remarkable changes. In the early years after WWII, this region of the state held only “sparsely populated rural and coastal communities comprised predominantly of lower income citizens”(Wilson *et al.* 1999, 1). The area was, and to a large extent still is, crisscrossed with farms. However, eastern North Carolina also boasts increasing strength in manufacturing, tourism, higher education, recreation, and fishing (Hart & Chestang 1996, SLNC 2001, Wilson *et al.* 1999). This chapter discusses five general topics: farming systems in the region, the diversification of farming, the dispersion of rural dwellers, the migration from rural to urban centers, and the effects of Floyd on the ecological, sociological and economic environments.

Farming in Eastern North Carolina

Tobacco farming has long been a mainstay of North Carolina farms since the “cigarette revolution” that followed WWI. Today almost half of the nation’s cigarette tobacco is produced in the Carolinas and Virginia. Farmers raise tobacco on small patches (less than 10% of their farm) (Birdsall 2001, Hart & Chestang 1996, Winsberg 1997). Because much of the land owned by farmers is wooded, it is not uncommon for cropland to occupy clearings in the woods, as opposed to large open fields, as seen in other states (although larger tracts of open farmland are seen in the coastal plain than elsewhere in the state). Consequently, “a farm of thirty tillable acres with five to seven

acres of tobacco could provide a reasonable livelihood for a family. Tobacco-producing areas thus supported the greatest densities of farm population and the smallest farms in the United States” (Hart & Chestang 1996, 550).

However, loss of congressional support for the crop, due to the health problems associated with tobacco consumption, is forcing tobacco producers to search for other lucrative crops instead (Birdsall 2001, Hart & Chestang 1996). This transition to other crops has been severely hampered because “no other field crop produces even close to the same gross return per acre as tobacco” (Hart & Chestang 1996, 550). Table 7 provides the average gross value of an acre of farmland for various row crops in 1992.

Table 7—Crop Returns for Four Crops in Eastern North Carolina

Crop	Gross Avg Value (1992)	Net per Acre (mid-1990s)	Yield per Acre (mid-1990s)
Tobacco	\$3223	\$1375	2259 lbs
Cotton	\$418	\$158	685 lbs lint
Corn	\$210	\$20	25 bu
Soybeans	\$185	<\$1	72 bu

Source: Hart & Chestang 1996

Elsewhere in North Carolina many tobacco farms tenaciously cling to tobacco production because their farms are not large enough to produce other row crops at a satisfactory scale. In addition, the “soils good for tobacco are not good for most other crops” (Birdsall 2001, 70). However, the tobacco-producing districts of eastern North Carolina are large enough to accommodate forays into other crop production, in addition to adoption of mechanized production techniques for various crops, including tobacco, cotton, corn and winter wheat (Furuseth 2001, Hart 2000, Hart & Chestang 1996).

Farm Diversification in Eastern North Carolina

Some other crops produced in substantial quantities besides tobacco are soybeans, corn, winter wheat, and cotton. Adoption of tractors, mechanical harvesters, and other modern techniques has allowed farmers to increase their acreage under production. (Birdsall 2001, Hart & Chestang 1996). For instance, in 1949, most farms in the coastal plain harvested 20-40 acres of crops. By 1992, the range of harvested acres of cropland per farm had increased from 80 to over 160 acres (Hart & Chestang 1996). In addition to mechanization of some farming tasks, this increase in acreage is also due to a consolidation of sharecropper units and the leasing of cropland from other farmers. This has been followed up by a vertical integration of the market for some farm products—primarily poultry and poultry food crops (Furuseth 1997, Hart & Chestang 1996, Winsberg 1997).

Soybean Production

The search by farmers for lucrative, stable commodities has been heavily influenced by changes in regulatory policy and in the prices of the marketplace. Soybeans were the first popular cash crop of the post WWII era. They were easy to grow and well-suited to the soils of the coastal plain. Unfortunately, they required large farms, were susceptible to infestations of nematodes, and had a very low profit margin. When the export market for soybeans plummeted in the early 1980s, so did the acreage under production (Hart & Chestang 1996, Winsberg 1997). Other crops under widespread production included winter wheat and corn. But like soybeans, they suffered from multiple problems, not the least of which was relatively limited profitability.

Cotton Production

Cotton has seen a resurgence among farmers in the Coastal Plain after a cooperative program successfully eradicated boll weevils in the mid-to-late-1980s. While cotton is far better suited to the summer climate regime in North Carolina than corn or other row crops, cotton requires large farms for production in order to justify the high capital outlay for equipment. Mechanical pickers and other equipment greatly reduce the farmer's need for seasonal labor, yet the crop also demands greater care by the farmer (Hart 2000, Winsberg 1997). "Tobacco [is] a very forgiving crop that tolerates careless treatment" (Hart & Chestang 1996, 566). Farmers long accustomed to the "ease" of tobacco crop management may require a few seasons before their cotton crop reaches its full production potential. Since economies of scale in cotton production require large farms, many cotton producers lease the additional farmland necessary to justify the cost of acquiring the equipment. The success of cotton farmers has encouraged others to shift into cotton production around the region. As a result, growth in cotton production is exceeding the state's processing capacity. Cotton gins across the state cannot handle the increased volume of cotton. Frequently picked cotton is "baled" into rectangular modules with the dimensions of a tractor trailer, then covered in plastic and left in the fields until a cotton gin is able to process it (Hart 2000, Hart & Chestang 1996).

Poultry Production

North Carolina farmers began supplementing their farm income by expanding into commercial poultry production in the 1950s, as chicken became a dietary staple in U.S. households. While commercial broiler (chicken) production began in the southeastern areas of the Coastal Plain, the practice has become widespread throughout eastern North

Carolina. Commercial broiler production is dependent upon vertical integration of the entire production cycle. Vertical integration assembles an entire production chain out of a variety of independent producers. In fact, today vertical integration accounts for the production of almost all of the nation's broilers (Barkema, Drabenstott, & Novack 2001).

The vertical integrator is responsible for overall management decisions, from coordinating the activities of the independent feed and broiler producers, to marketing and distribution of the final product. More importantly, the integrator also bears the brunt of price fluctuations within the marketplace (Furuseth 1997, Hart & Chestang 1996). In the case of North Carolina broiler production, the integrator is usually a chicken processor or feed dealer. Two of the best-known vertical integrators of broiler production are Tyson and Perdue. The vertical integrator maintains relationships with chicken hatcheries, feed mills, processing plants, and farmers (who may produce feed and/or raise chickens). The integrator provides the farmer with day-old chicks, feed, training, and a guaranteed price. The farmer provides the labor, broiler houses for grow-out operations, and utilities. The integrator coordinates delivery of a somewhat standardized product (e.g. chickens of a certain species and size) to the processor. After processing, the final product is then shipped to its intended market (Hart & Chestang 1996).

Just as the production of chickens has been vertically integrated, so too, in recent decades, has the production of eggs and turkeys. It typically takes five months to raise a turkey to a suitable market weight (34-38 lbs), as opposed to two months for a chicken. Although commercial turkey production is more labor- and cost-intensive than egg or chicken production, the overall methods are similar enough that adoption of large-scale turkey production in eastern North Carolina has increased tremendously since the 1970s

(Hart & Chestang 1996, Hart & Mayda 1998).¹ By 1992, North Carolina was producing more turkeys than any other state: twenty percent of the nation's total. The transition to poultry production has been so widespread and so successful, that in 1992 more farm revenue in the Coastal Plain was generated by the poultry industry than by tobacco production (Hart & Chestang 1996). Yet the diversification of farms in the Coastal Plain does not stop there.

Hog Production

The similarity of commercial hog production using a confinement feeding system to that of poultry production is enough so that since the 1980s, farmers in the Coastal Plain seem increasingly willing to undertake it. This allows for the raising of more hogs on less space than traditional methods (Faruseth 2001, 1997). The large-scale farm often has more than 2000 hogs, and “mega-farms” have more than 10,000. Currently, 88% of the hogs in the U.S. are raised on large hog farms (Benjamin 1997). The traditional Corn Belt hog-farming states, Iowa in particular, are attempting to restrict the role of corporate farmers and vertical integrators in order to protect the numerous small producers in those states (Barkema, Drabentstott & Novack 2001; Drabentstott 1998). As a result, large-scale hog production is increasing rapidly in North Carolina, along with Colorado, Mississippi, Missouri, Oklahoma, Utah and Wyoming. By the mid-1990s, North Carolina was second only to Iowa in U.S. hog production, thanks to its dramatic growth in large-scale hog operations (Table 8). Environmental concerns are common with large scale hog farms, yet Corn Belt states are concerned about the loss of hog processing facilities to states with growing, vertically integrated hog farms (Barkema, Drabentstott, & Novack 2001; Benjamin 1997; Drabentstott 1998; Hart & Mayda 1996).

Table 8—Average Hog Production Per Farm

Year	North Carolina	Iowa	U.S.
1949	11	83	31
1992	2686	787	592

Source: Hart & Chestang 1996

The benefits of commercial hog production mirror those of poultry production: relatively standardized quality, predictable growth rates, and species with desirable attributes, such as leaner flesh or faster weight gain (Benjamin 1997, Furuseth 1997, Hart & Chestang 1996). Unlike poultry producers, though, hog production in North Carolina is not completely vertically integrated.

The hog companies provide many of the same inputs and services as poultry integrators: piglets, feed, management advice, and a set fee to the contracting farmer. They even provide veterinarian service, which is important as swine are quit susceptible to a number of fatal illnesses. While some hog companies process the hogs in their own plants, they differ from poultry integrators in that they do not market the hogs. Those companies lacking processing plants of their own establish contracts with processing plants to provide a steady supply of uniform hogs. Yet the hog companies do not control the distribution of the final product (Barkema, Drabentstott, & Novack 2001; Benjamin 1997; Faruseth 2001; Hart & Chestang 1996).

In exchange for a guaranteed price for hogs at market weight, farmers provide labor, utilities, and structures that meet the hog company's guidelines. The farmer is liable for animals that die, the possible loss or cancellation of the contract, and any environmental damage that the production facility creates (Barkema, Drabentstott, & Novack 2001; Drabentstott 1998; Faruseth 1997). Environmental damage is a significant risk since "a mature hog produces four times as much solid waste as do people" (Hart &

Chestang 1996, 563). In addition, farmers wanting to diversify into hog production must obtain a large amount of start-up capital. Initiation of full-scale hog production requires huge capital outlays (exceeding \$1 million per farm) and a lot of expertise with swine husbandry. Swine are not only very susceptible to disease², they are intolerant of temperatures greater than 80 degrees Fahrenheit. In summer they must be sprayed with water in order to supplement the cooling systems in operation in the hog buildings (Hart & Chestang 1996).

Full-scale hog production requires several types of buildings: the breeding barn, the gestation barn, the farrowing house, the nursery, and the finishing house. Once piglets are old enough to leave the farrowing house, they are sent to a nursery for several weeks. Afterwards they are moved to a finishing house. It typically takes six months for a piglet to reach market weight. Many farmers, however, cannot afford to begin at this level of sophisticated production. They tend to enter the hog business with just a few finishing barns (Benjamin 1997, Faruseth 1997, Hart & Chestang 1996). Although large-scale hog production is concentrated in the southern part of the Coastal Plain, there is significant expansion northwards into the rest of eastern North Carolina (Faruseth 2001, 1997, Hart & Chestang 1996). The growth of this industry in North Carolina proved especially problematic after a series of environmental accidents in the early 1990s that resulted in waterways polluted by hog wastes. Since then, environmental and local regulations have been strengthened. In addition, "low returns to capital and labor have pushed many farmers out of the hog business and prompted others to expand in order to achieve lower costs per unit of production" (Benjamin 1997,5). Those farmers that stop raising hogs typically continue to farm, but they do not supplement their crop income with revenue

from hog production (Benjamin 1997). These difficulties, coupled with limitations in pork processing capacity in the state, are slowing further growth of hog production in North Carolina (Faruseth 2001, Drabenstott 1998).

Not all farms in the state are enjoying the “entrepreneurial renaissance” that diversification seems to be bringing. Increasing numbers of farms, especially in the Piedmont and Appalachian areas of the state are losing operators to off-farm employment (Hart 1992, Hart & Morgan 1995). In fact, for some, farming is no longer their principal form of employment.³ Another option for rural farmers to improve their financial circumstances is to sell portions of their farmlands that border the roadway. In many cases, these lands are then converted into single family homesites—often for families of modest income (Birdsall 2001, Hart & Morgan 1995).

Dispersed Rural Living

It may seem contradictory to state that North Carolina has seen an increase in density of its dispersed rural population. Yet the gradual changes in the state’s economy (such as overall increases in manufacturing, and changes in agricultural production regimes) has “released an abundance of low-wage workers for the new factories, plus an abundance of low-cost land that enables those workers to live as and where they wish” (Hart & Morgan 1995, 110). The farmers convert their land to residential units, and the homeowner then develops the homesite in a fashion according to his abilities.

Hart & Morgan (1995) detailed a pattern of conversion of agricultural land. The following are the most consistent features of this land conversion:

- Sales of farm plots are piecemeal
- Homesites are situated on sold portions of farmland located adjacent to a roadway
- Homes lack the uniformity and standardization observed in “developed” subdivisions

- Residents of these homesites commute long distances to work, and are often not in the higher income brackets
- There are few commercial establishments on converted farmland
- Large farmholdings or farm property operated by prosperous owners is not converted into residential or commercial property.

Sporadic clusters of residences, typically mobile home parks, as opposed to residential subdivisions, are found along these stretches of rural roadside development. In general, however, the majority of residences are individual units placed in a purely “roadside random” pattern (Hart & Morgan 1995, 116). These homes run the full gamut of possible structures: shacks and shanties, cabins and cottages, mobile homes and mansions. In reality, though, proportionately few of the homes are those most associated with the middle and upper income groups. A major reason for this is that the population in the Coastal Plain is composed predominantly of people whose income levels are in the lower income brackets.

In fact, mobile homes are quite common. They withstand well the limited seasonal rigors of North Carolina. They are also very affordable and quick to assemble. For people of limited skills, education, and income, these homes are excellent starter homes. Even the long commutes can be considered a benefit. Many rural residents commute across county lines, for example the average commute in Pitt County is 50-60 minutes (45 miles or 72 km) each way. And over 700,000 people live within a 45-mile radius of the County seat: Greenville (PCDC 1999). In areas where layoffs are frequent (as seen in the manufacturing and agricultural sectors), “a worker who has been commuting to a discontinued job might find it easier to commute to a different job than it might be for a laid-off worker who lives close to the place of employment” (Hart &

Morgan 1995, 110). This is true whether the worker is laid off because of an industry or economic downturn, or because of a disaster.⁴

Additionally, the long commute allows homeowners to maintain their “attachment to place” (Hart & Morgan 1995, 116). This is an important trade-off: place over leisure time. The ancestral connections of many residents of eastern North Carolina to the area gives them “deep roots” of attachment. Their predominant lifestyle along the rural byways that link the villages, towns, and crossroads communities with the larger thoroughfares that lead to distant urban centers is much akin to what Pulsipher (1999, 538) describes as “subsistence affluence.” Actually, Pacific Islanders first coined the phrase to describe their lifestyle. Subsistence affluence is a manner of living in which people are able to enjoy “a safe and healthy life on relatively little formal income” (Pulsipher 1999, 538). They reduce their expenditures on food by hunting, fishing, raising homegrown foods, and gathering foodstuffs found in the wild. Their ability to earn an income is curtailed due to limited access to information and opportunity. As a result those who are “affluent” at the subsistence level possess few manufactured goods.

Those North Carolinians who enjoy this type of “subsistence affluence” share the same risk as the rural poor elsewhere around the globe: they possess few resources to draw on during times of prolonged or intense hardship, such as during disaster’s aftermath. Catastrophes like Floyd can quickly eliminate all of the emotional, material, and financial security of families and individuals through the destruction of the home, its residents, its contents, or the other elements of daily life: crops, cars, jobs, livestock, pets. The traditional safety net for disaster victims is destroyed if the victim’s family and friends were themselves displaced by the disaster. Coping is particularly difficult for

those with limited skills, education, or knowledge of aid or assistance networks (Oliver-Smith 1999b, McDonnell *et al.* 1995). Yet not all of the residents of coastal North Carolina, nor indeed the state itself, are rural dwellers. And the last decade has seen a decided growth in the state's urban centers.

From Rural to Urban

For the first time in the state's history, there are more urban than rural dwellers—despite the increasing dispersal of country homesites along rural byways (Census 2001c, Delia 2001). In fact, North Carolina is now ranked as the 11th most populous U.S. state. The population changes in selected North Carolina cities are presented below.

Table 9—Population Change in Selected North Carolina Cities

City	1990 Population	2000 Population	% Change
Charlotte	395,934	540,828	+36.6
Greenville	44,972	60,476	+34.5
Raleigh	207,951	276,093	+32.8
Rocky Mount	48,997	55,893	+14.1
Wilmington	55,530	75,838	+36.6

Source: US Census (2001c)

While new settlers to the coastal region increased the area's population by 9.3%, it lagged behind the state in general, whose immigration rate was 15%. Hispanics enjoyed the most dramatic increase in population between 1990 and 2000. They made up only 1.2% of the state's population in 1990, and now make up almost 5% of the state's population. The growth of African American residents has maintained their numbers at essentially the same proportions of the state's population. The population of white non-Hispanic residents has also grown, but their overall representation within the state's population has diminished slightly (approximately 5%). Today, eastern North Carolina

now boasts that it has a more culturally diverse population than the rest of the state (Table 10) (Census 2001b, Delia 2001).

Table 10—Representation of Major Ethnic Groups in North Carolina in 2000

Group	Eastern NC	State
Caucasian, non-Hispanic	61.33%	70.16%
African American	31.75%	21.41%
Hispanic	4.32%	4.71%

Source: Census 2001b, Delia 2001

Note: Table does not sum to 100%

Yet the demographic changes that took place within the state in the last decade were little known during the summer of Floyd; four facets of this demographic shift are relevant to the impact of Floyd and the length of time needed for recovery from the flood:

- Out-migration from small communities
- In-migration at urban centers
- Growth of the Hispanic population
- Development's alteration of the natural landscape during this period of population growth.

Each of these facets is addressed in turn.

Out-Migration from Small Communities

Although seemingly contradictory, this immigration to the Coastal Plain did not prevent the out-migration of people from small towns, villages, and crossroads communities. Were people “pulled” to urban centers by the prospect of jobs, education, or other amenities? Or were the “pushed” there when Floyd inundated their homes, workplaces, and communities? Because the census occurred so soon after Floyd, the extent of Floyd's influence on this rural to urban shift is unclear. Given that the state as a whole was enjoying a substantial immigration to its larger urban cities in the Piedmont (and away from the destruction in the Coastal Plain), there may indeed be some economic

or cultural “pull” factors attracting new residents to the state. But the disruption and displacement the flood wrought cannot be completely discounted.

For example, although 40 of the 44 counties in the Coastal Plain saw population increases by 2000, one third of all municipalities in the region lost part of their population since 1990. Almost all of the towns that suffered population losses had a base of fewer than 5000 residents in 1990. Only Kinston had a population greater than 25,000 (Delia 2001). In fact, although Pitt County had one of the fastest growing populations between 1990-2000 (it increased 24%), the county also saw many of its smaller towns lose residents (Table 11).

Table 11—Comparison of Population Change (1990-2000) in Selected Small Coastal Plain Towns with Greenville, North Carolina

Town	% Change in Population	Flooded by Floyd
Bethel	-5.3	Total
Kinston	-6.4	Partial
Grifton	-11.7	Partial
Belhaven	-13.3	Degree Unknown
Princeville	-43.1	Total
Seven Springs	-47.2	Total
Greenville	+34.5	Partial

Source: Delia 2001

It is convenient, but not necessarily accurate, to assume that these residents simply moved to Greenville, the county seat of Pitt County and one of only a few urban areas in the Coastal Plain. Yet there is no clear evidence that this actually happened. Those displaced by the disaster frequently share a residence with family or friends until they get back on their own (Drabek 1994, Gettie *et al.* 2001, Gladwin & Peacock 1997, McDonnel *et al.* 1995). However, despite the deep roots of many Coastal Plain residents, the families or friends providing shelter may in fact live in different counties or different

regions of the state. Needless to say, this involuntary migration is making the survival of small towns in eastern North Carolina problematic.

In addition to the sheer physical damage that these small communities endured, their already small tax bases are contracting due to the loss of their already modest population base. This requires them to change the scale of their community (such as its retail, fire, police, health, and other services). However, it is unknown if their population is still adequate to maintain some degree of community self-sufficiency. As small communities struggle against dissolution, larger cities are facing a different set of issues.

In-Migration at Urban Centers

Population growth can be a blessing or a curse. Much depends on the needs of the new arrivals and the city's ability to fulfill those needs. That portion of the population growth in North Carolina's cities that is due to the resettlement of displaced flood victims can create a variety of problems for city officials. A major concern is the potential for a disaster, such as Floyd, to create a new group of homeless (and even jobless) poor within the city's midst. This is not a reference to those who are *temporarily* displaced, but to those completely uprooted due to the disaster's devastation; those who cannot return to their former homes. If the numbers of homeless victims are further supplemented by arrivals of displaced disaster victims from other locations, the city resource managers may be hard-pressed to come up with enough suitable, affordable housing for the victims.

One way in which significant numbers of residents are permanently uprooted is if they rent a residence (e.g., mobile home or apartment) in a clustered development in or near the floodplain. Should the property owner decide to participate in the Federal "Buy-Out" Program, the residents will have no hope of returning to, or repairing their former

residence. If there is a shortage of affordable housing in their original community, they may migrate to a metropolis in the hopes of beginning again there.

The “Buy-Out” Program refers to the federal government’s program to purchase severely damaged homes that are located in harm’s way. This program operates solely on a voluntary basis. No owner is forced to sell his residence. He or she can repair or rebuild the structure, so long as it meets all appropriate zoning, building, and planning guidelines. For flood victims, this often requires elevating the structure. If the homeowner suffers a second flooding of his home, and files a claim for the second flood event to the National Flood Insurance Program, then the homeowner will lose the option of rebuilding (Wenger 2001). So many homes in eastern North Carolina met the criteria for “buy-out” that there was not enough money available to purchase them all. So the standards for inclusion within the “Buy-Out” Program were raised for this particular disaster⁵. Nonetheless, representatives of Greenville/Pitt County Disaster Recovery Center report that there are currently more than 6000 residences slated for “buy-out” by 2003.

Housing problems are not the only difficulty urban centers face when a disaster strikes. A “domino effect” might occur if the local industry sectors are not able to absorb these arriving disaster victims into their ranks of employees. If the business sector itself is “displaced” due to the disaster, then the city’s unemployment rolls could swell further, as could the expected losses to the tax base. Difficulties notwithstanding, cities also have an obligation to provide emergency services to its citizens in the wake of a disaster. The disaster’s aftermath is an unfortunate time to discover that emergency management plans did not account for linguistic or cultural hurdles it would face.

Growth of the Hispanic Population

The state's rise in Hispanic agricultural workers, and more recently in other occupations (such as retail or hospitality work), is not a surprise, given the national demographic trends in recent years. This increase is also as result of the state's increased recruitment of Latinos through the federal H2A (Guest Worker) Program (Cravey 1997). Many of these immigrants work on the farms or in the meat processing plants (Barkema, Drabentstott, & Novack 2001; Cravey 1997; Winsberg 1997). However, in terms of disaster response and recovery, the implications of this demographic shift were unexpected. When Floyd struck, thousands of native Spanish-speakers were not able to understand the emergency information distributed through the English-language media. This included information on the location of shelters, the availability of assistance, the safety of the drinking water, or other vital information. In fact, the emergency management personnel at local levels never adequately prepared to assist a linguistically diverse population (Delia 2001).

No doubt the state's long history as a predominantly "English-only" state contributed to the difficulty in assisting its Hispanic population in the wake of Floyd. The dearth of public service personnel with Spanish language skills created numerous problems in getting aid to Hispanics affected by Floyd. Latinos end up in unsafe or substandard housing because Latinos primarily fill low-wage, low-skill jobs (Cravey 1997, Winsberg 1997). Their occupation of such housing left them disproportionately more vulnerable to being displaced by the flood. Those who heard about, and moved to, emergency shelters were hindered by the language barrier. Executives with the Salvation Army and the North Carolina Interfaith Disaster Response reported that shelter workers required reminders to track down "someone" (usually a Hispanic evacuee who

understood English) to relay to the other Spanish speakers any information being disseminated. This included when meals are served at the shelter, how to fill out aid request forms, or how to contact employers to determine if they can return to work yet.

Development's Alteration of the Natural Landscape

A final element that played a major role in the scope of the disaster of 1999 was the alteration of the natural landscape. Development has left its mark on the drainage patterns of eastern North Carolina. The pattern of development during the 40 years of growth in eastern North Carolina (1960-2000) heavily influenced the degree of vulnerability to flooding: by citizens, by businesses, and by the natural environment. The growth within eastern North Carolina has not always factored into account the alteration of the drainage basins within the region. As a result, the area was setting itself up for the state's deadliest and costliest natural disaster in the twentieth century (Bales, Oblinger & Sallenger 2000; FEMA 2000b).

Human development in recent decades has compounded the problems associated with heavy rainfall. This development includes the construction of buildings, parking lots, and other impermeable surfaces that do not allow for the soil's absorption of water. Typically, the rainfall that cannot be absorbed by the soils flows overland as sheet flow. Increased development in turn increased the amount of impermeable area, and therefore the amount of runoff that must be carried to and by the rivers and their tributaries (Riggs 2000).

Human alteration of the floodplain is closely linked to increased human settlement in eastern and coastal areas of the state. As settlement expands further into or along floodplains, modifications are made to the natural environment. Five common

alterations of the floodplain occurred across eastern North Carolina in response to population pressures:

- Draining of wetlands
- Increasing the amount of area covered by impermeable substances (such as asphalt or concrete)
- Channeling of tributaries
- Constructing intentional and unintentional flood containment structures, and
- Changing the land use to uses that increase stream flow or stream damage in flood events

(Riggs 2000, Wood 2000). These alterations were significant contributors to the severity of flooding that eastern North Carolina experienced in 1999. Each of the five are discussed in turn.

Loss of wetlands

North Carolina is no exception to the general pattern of wetlands destruction that has occurred around the United States in the last 40 years. While this may reduce the threat to humans by mosquito-borne illnesses (such as West Nile Disease, malaria, or encephalitis), it increases the danger to human communities from flooding. For example, wetlands soil (hydric soil) is primarily composed of organic matter, such as decaying trees, leaves, or other plant matter. Hydric soils act like a sponge; they are able to absorb up to five times their own weight in water (Wood 2000). As development increased in eastern North Carolina, wetlands were compromised or sacrificed outright. Some marginal farmlands and wetland areas were drained by constructing ditches or other drainage outlets (Hart & Chestang 1996, Wood 2000). As population pressures increased, some wetlands were eliminated to allow for residential or commercial land development. This replacement of area that can absorb runoff with an impermeable surface that cannot reduces the area's ability to absorb storm water; consequently, the volume of runoff

flowing into the rivers and sounds has increased (Godschalk 2000, Wood 2000). This increased volume of surface runoff exacerbates any flood events (Bales, Oblinger & Sallenger 2000).

Increase in impermeable areas

An obvious byproduct of expanding human communities is the increased area covered by impermeable substance. Asphalt and concrete are two obvious features of the man-made landscape that do not allow water to percolate through them and down into the soil below. The construction of roadways, subdivisions, shopping centers, and related human activities significantly alters the landscape's ability to absorb storm water. Furthermore, impermeable substances like asphalt accelerate, rather than slow, the flow of surface runoff. Thus, the volume of runoff increases after a given storm event, because of the increased impermeable areas, and the speed with which this runoff reaches the major tributaries or rivers in a drainage basin also affects the drainage system's ability to absorb this runoff. As a result, expanding the impermeable surface areas in a region alters the manner and direction of storm water flow.

Channeling of tributaries

Any water body that feeds into a river or main trunk stream within a drainage basin is considered a tributary. Creeks and streams are natural tributaries; drainage canals and ditches are man-made tributaries. There were a number of pragmatic reasons for channeling of runoff in eastern North Carolina. Most focused on increasing the speed of runoff in order to significantly reduce the "residence time" of standing water on cropland,

homesteads, and roadways. The faster the runoff is removed, the sooner things can return to normal.

To some extent this works with periodic storm water events. Yet with each additional change to the drainage pattern on the landscape there is a concomitant change to the floodplain. A threshold is reached in which the rapidity and volume of runoff being channeled to the main trunk streams are more than they can accommodate. This creates or exacerbates flood events along the main trunk stream and its tributaries.

Should the outflow from the main trunk streams be held back, as by the advancing counterclockwise winds of Hurricane Floyd, then the tributaries feeding the main trunk stream also struggle to accommodate more water than they can handle. Of course, drainage channels are not the only means of shifting the direction of storm water flow.

Flood containment structures

As more development occurs on or near a floodplain, attempts to create “permanent solutions” to the flood hazard are undertaken. Beginning in the 1950s, the solution for many flood hazards was to construct barriers, such as levees, to protect the community. Because they prevented floodwaters from inundating an area, these structures were considered to be a permanent solution (FEMA 1987, USACE 1998). Unfortunately, there are no permanent solutions. Physical structures succeed in altering the flow of water within the floodplain, yet too often these barriers simply transfer (and increase) the flood risk to communities elsewhere. More recently, the emphasis has been on nonstructural prevention strategies, such as restoration of wetlands and removing residents and businesses from floodplain areas (FEMA 1987). Both structural and nonstructural approaches are intentional attempts at flood containment.

Unintentional flood containment structures are the by-product of development of human-use activities within the floodplain. The most often cited is the “road-dam” (FEMA 1987, USACE 1998). As roads are built across low-lying areas, they are raised and graded to accommodate a 50-year flood event at the time of construction.⁶ These elevated roads act both to channel storm water flow along the road’s flanks, and to prohibit large-scale runoff of storm flow across low-lying lands due to this elongated barrier. Thus, roads become dams behind which storm waters accumulate.

When excessive rainfall or runoff reaches the road dam, a number of problems can arise. These include: culverts that are overwhelmed, roadbeds that become supersaturated and develop holes in the pavement, or flooding of the road itself. Any runoff that channels along the roadway and reaches a bridge can likewise create a number of problems, including: scouring of the embankments supporting the bridge (thereby rendering the bridge unsafe); damaging or jeopardizing the bridge by piling debris up against the bridge or its supports; or contributing to the flooding of the bridge due to the combination of river flow and the channeled flow from the road dam.

Due to the pattern of development in eastern North Carolina, and the high number of drainage basin tributaries, there are a tremendous number of roads and bridges throughout the region. In fact, at the peak of flooding from Hurricane Floyd, over 1000 roads and 15 bridges were impassable (flooded, damaged or destroyed) because of the floodwaters (FEMA 2000b, McComas 2000, Stephenson 2000, Wilson *et al.* 1999).

New land uses that increase stream flow

It is not simply the “paving of the countryside” that increases the amount of runoff entering streams rather than percolating down through the soils. Changes in

farming practices in the 1990s also contributed to the scale of flooding by Floyd and, more importantly, to the magnitude of damage the floods caused.

In the early 1990s, Congress began withdrawing its support, in the form of subsidies, for tobacco production. Tobacco had a very lucrative return-on-investment for those who grew it.⁷ Losing the subsidies was a serious blow to North Carolina farmers. Many farms are not large enough to achieve an “economy of scale” in producing other row crops. Many also lack the financial wherewithal to invest in the expensive new equipment needed in changing crop production regimes (Hart & Chestang 1996).

In an effort to maximize the value of moderate to small farms, agricultural producers across the state began supplementing their crop production with livestock production. Large livestock, such as cattle are not common, but high-density poultry and swine operations are becoming more frequent (Hart & Chestang 1996). Both “broiler” (chicken) and hog operations contributed hundreds of tons of animal waste to Floyd’s polluted floodwaters (Bales, Oblinger & Sallenger 2000; Marsh 2000). However, the hog farms pose serious long-term challenges to the drainage basins of North Carolina as well. Each hog farm (which is often part of a crop farm) must have a hog waste lagoon. These privately operated retention ponds are expected to provide manure for crop fields. However, during flood events these lagoons may be overtopped with rainfall (which allows the waste to float downstream on the flood currents), or they may rupture completely. Attempts to reduce the risk of a lagoon break require releasing some of the retained waste either directly into the drainage basin waterway, or indirectly into the waterway. The indirect method involves lowering lagoon levels by spraying waste onto

farm lands; however, the farm fields cannot absorb it, as the soils were already saturated from the excessive rainfall (Bales, Oblinger & Sallenger 2000; Marsh 2000; Dove 2000).

Another change in land use that can increase the amount of stream flow is the establishment of private or municipal reservoirs or water treatment facilities. A number of wastewater plants were overtopped or ruptured by Floyd's storm waters. Like the hog lagoons, they spilled their millions of gallons of fluid contents into the already overburdened rivers (Bales, Oblinger & Sallenger 2000; FEMA 2000b). In addition, several interviewees for this research also reported that a reservoir upriver from Greenville made the decision to release water rather than risk having the entire structure collapse. This, too, ratcheted up the size of the juggernaut moving down the Tar River.

How Bad Was It?

Floyd's toll on the people of North Carolina was extraordinary. In the U.S., disruptions caused by disasters are frequently described in terms that are easy to quantify: insurance losses, shelter population, and death toll. But the effects ripple outward. A dollar figure for insured losses does not convey the number of homes damaged or destroyed. The number of evacuees who seek public shelter is typically a small portion of the total population that evacuates. For example, in Pitt County, almost four percent of evacuees went to shelters (Geddie *et al.* 2001, Wilson *et al.* 2001). Those who travel out of harm's way can find themselves in a dangerous situation as a sinkhole opens beneath the roadbed ahead of them, or as they attempt to drive across a narrow flooded strip of roadway. The number of people rescued is not often calculated for disaster reports. Table 12 below summarizes many of the quantifiable impacts of Floyd on families in the Coastal Plain.

Table 12—Hurricane Floyd's Toll on NC Households

Death Toll in North Carolina	51
Number of People Rescued	2700+
Shelter Population	60,000
Estimated Number of Jobs Lost	31,000
Number of Residences Destroyed	8,300
Number of Residences Damaged	50,000
Number of Temporary Residences	2,534
Number of Residences Bought by Government*	1888
Number of Drinking Wells at Risk of Contamination	400,000
Estimated % of Residences with Flood Insurance	20%

Sources: FEMA 2000b, Gallagher 2000, Stephenson 2000, Wilson *et al.* 1999

Note: * indicates the number of households bought out by 2001; currently >6000 (total) are slated for buyout by 2003

Numerous residents who were forced from their homes by the floodwaters became a quasi-nomadic population. Family and friends were often those most able or willing to provide temporary lodging to the displaced (Wilson *et al.* 2000). In some cases, employers provided shelter for them. In others, their cars became their residences. The difficulties of finding a residence were exacerbated by an already existing housing shortage (especially in small communities), and by the immigration occurring within the region (Census 2001b, 2001c, Delia 2001).

Those who suffered the greatest losses from Floyd are also most likely to suffer from posttraumatic stress disorder as well (Geddie *et al.* 2000). For example, many of those who were displaced by the flood still experience deep anxiety to thunderstorms and other precipitation events (Edge 2000). This was particularly evident during this research, when the remnants of Tropical Storm Allison passed through Greenville after having deluged part of Houston, Texas only a few days prior. Quite a number of Greenville residents who had been impacted by Floyd were clearly in distress over the light but prolonged showers that Allison brought.

When placed back into context of what these families experienced, their distress is understandable. “Families who were displaced from their homes were highly transient, *moving every few days or weeks* between various family members, friends, and hotel rooms” (Geddie *et al.* 2000, 8, italics added). As schools reopened, some hotels were (for a time) converted to shelters to house evacuees. While some evacuees paid for their hotel accommodations out of their household finances, it is possible that some had the bill taken care of either by assistance organizations, employers, or the government.⁸

This “disaster nomadism” of displaced families influenced the children as well. The movement from one residence to another often resulted in children moving to new school districts (Geddie *et al.* 2000, Holmes 2001). Not surprisingly, evaluations of students’ performance since the disaster (and its subsequent household upheaval) indicate that they are no longer on the same trajectory of educational improvement as before the disaster. The students’ evaluations indicate that their abilities are significantly less than where they should be, had no disruption occurred (Holmes 2001).

Furthermore, Floyd has the seldom-mentioned distinction of being the state’s deadliest storm in the last one hundred years (Barnes 2000, Elliott 2000, NCDC 2000, Zagier 2000). In fact, only the hurricane of September 1883 killed more North Carolinians: 53 (Elliott 2000). Granted, Floyd’s death toll of 51 fatalities is not as shocking as the thousands who perish in disasters in the developing world (Economist 2001, McKinley 1999, NYTE 1999). Yet Floyd’s status as a truly deadly storm ought to garner more mention of the death toll, rather than the “dollar toll.” Similarly, the indirect, or postimmediate effects are also less often reported. For example, the death rate among the elderly doubled in the weeks after Floyd. This was especially true for those elderly

who evacuated because of Floyd (Wilson *et al.* 1999). Even the sudden demand for scarce resources, such as bottled water can severely disrupt already strained households.

Perhaps just as staggering is the impact of Floyd on a household's income level. Over 19% of residents in Pitt County reported suffering lost income in 1999. A year later, almost 8% of the same group was still suffering from lost income due to the flood (Wilson *et al.* 2001). Part of this can be attributed to the temporary closure of firms during the initial recovery phase. Similarly, the loss of an estimated 31,000 jobs in the Coastal Plain also influences the household income level as well. In a region where the average per capita income is only 80% of the national average (FEMA 2000b, Wilson *et al.* 1999), such a prolonged reduction in income is serious. However, it cannot be determined whether the income loss is resulting in the firms' loss of market, or if the market contraction is reducing the labor hours available to employees. Wilson *et al.* (1999) estimate that 21,000 firms lost some portion of their market as a result of Floyd (Table 13).

Table 13—Estimated Effects of Hurricane Floyd on Businesses in Eastern North Carolina

Type of Disruption	Small Firms (1-9 empl)	Medium Firms (10-99 empl)	Large Firms (100+ empl)	Total
Physical Damage	19,766	5,188	284	96,502
Business Interruption	41,750	10,788	593	53,131
Loss of Market	16,982	3,801	134	20,917
Avg # Days Shut Down	6.9	5.75	2.95	6.64

Source: FEMA 2000b, Wilson *et al.* 1999

A cynic might argue that businesses can recover more quickly from a disaster because they have insurance coverage. However, possession of a policy is no guarantee of payment; fire policies do not cover flood damages—nor do hurricane policies. Hurricane policies cover wind damage, and in some cases storm surge damage, but not

damage caused by floodwaters—even if the hurricane was the cause of the flood. On the other hand, larger, or more capital-intensive firms have some form of insurance coverage. Such coverage is usually a requirement by lenders to protect their investment. Yet roughly one out of every six businesses had no insurance at all (Table 14) (Wilson *et al.* 1999).

Table 14—Average Level of Insurance Coverage by Firms in Eastern North Carolina

Type of Coverage	Small Firm	Medium Firm	Large Firm
Any	83%	91%	100%
Liability	84%	88%	83%
Casualty	79%	84%	83%
Fire	75%	80%	83%
Lost Revenue	21%	33%	54%
Flood	13%	17%	36%

Source: Wilson *et al.* 1999

Direct impacts to businesses were not the only effects hindering the people and firms of the region. Public and private forms of infrastructure were also disrupted. For example, 33 dams failed completely, 59 were damaged, and another 84 overflowed (Stephenson 2000). On average, disruption of road access and water service had the most prolonged impact on firms in the Coastal Plain (Table 15). An important consideration in evaluating this table is that it reflects a survey of firms in all industry sectors, located throughout the Coastal Plain. A breakdown of disruption times based on industry or county would also be informative, but is unavailable. For instance, while all firms need adequate road access, tourism-based enterprises also depend heavily on water and sewer services. Restaurants cannot legally operate without active water and sewer services. For this reason, several respondents reported that employees were forced to vacate their hotel rooms when the water service was shut down because of the flood.

Table 15—Average Number of Days of Infrastructure Disruption of Businesses in Eastern North Carolina

Infrastructure Disruption	Small Firms	Medium Firms	Large Firms	Overall Avg
Roads	5.48	6.93	4.43	5.74
Water	4.51	4.63	5.87	4.54
Electricity	3.68	2.47	2.56	3.44
Telephones	3.06	2.73	2.34	2.99
Trash Removal	2.54	1.99	0.83	2.42
Sewers	1.45	0.84	1.73	1.34
Parking	1.09	1.29	1.36	1.13

Source: Wilson *et al.* 1999

On the other hand, large- and medium-sized firms may have accessed generators and cell phones, thereby reducing the disruption caused by a general loss of these infrastructure elements. However, it is also possible that large and medium-sized firms suffered less prolonged disruptions of electricity and phone service because they were located in areas with less overall damage, faster service reconnections, or both. For example, in Pitt County alone there are twenty large employers; of these, half employ 500 or more people (PCDC 2000). Almost all of these enterprises are located in the industrial area north of the Tar River as it cuts through Greenville. The flooding in this industrial district was uneven, and the restoration efforts were swift. The speed of service restoration is in large part because many of the organizations responsible for the country's recovery efforts are located in the city of Greenville itself, or near to the aforementioned industrial district.

There is a trend seen between increasing firm size and the increasing average length of disruption due to sewer or parking problems. Newer firms with fewer employees tended to elevate only the business building, and not the storage yards or parking areas. It was common with larger firms to see drainage canals and retention ponds on the property. Disruption of sewers can create backups in the drainage system,

and these man-made canals and ponds are transformed from flood prevention devices into flood hazards. Consequently, it was not unusual for one firm to report flood damage, and a nearby canal or retention pond to be the culprit.

Parking may also be a more significant factor for large employers rather than small establishments as well. While retail shops, restaurants, hotels and related activities depend on parking for customers and staff, they have a higher degree of turnover in parking spaces than would a manufacturing plant running three eight-hour shifts daily with several hundred assembly line workers each shift. Throughout eastern North Carolina commuting is common, and mass transit is not a popular means of traveling to work. In the aftermath of Floyd firms' parking lots were further restricted because of lingering polluted floodwaters and debris piles awaiting removal (Wilson *et al.* 1999). Some interviewees also reported that their establishment set up temporary "field headquarters" in shopping center parking lots. They also reported observing displaced individuals or families that opted to live in their cars using the parking lot for their temporary homestead. Very large firms possess the resources available to out-source the repair and cleanup activities of their facilities. But the subcontractors hired to perform these tasks typically set up in the parking lot, thereby reducing the overall parking area available. Those displaced families residing in their car in the wake of a disaster are forced to search for somewhere else to park when the time for sleep finally comes. While some of the effects of Hurricane Floyd have been presented in this and the preceding chapters, the following chapters discuss the results of this study. The next chapter presents the results of the comparative analysis of the survey questionnaire.

Notes

¹ In fact, one of the biggest turkey producing areas in the entire U.S. is centered around the town of Turkey, N.C. (Hart & Chestang 1996).

² Hart & Chestang (1996) report that most producers limit the risk of disease transmission by requiring all employees and guests to the hog buildings pass through a “locker room” type of facility where they must shower, wash their hair, and change clothing before they enter or leave the hog buildings.

³ This transition to off-farm employment is more prevalent in the Piedmont; see Hart 1992, and Hart & Morgan 1995.

⁴ After Hurricane Andrew struck southern Dade County, Florida in 1992, providing transportation for lower-income, low skilled, laid-off workers was a major concern for local governments. Providing new or improved forms of mass transit for affected lower-income residents was not a significant issue in Pitt County, North Carolina after the floods of 1999. The Floridian workers were accustomed to shorter commutes to nearby jobs, unlike the North Carolinian workers (PCDC 1999).

⁵ The NFIP standard is at least 3 feet of floodwater inside the residence. In Pitt County this was raised to 5 feet.

⁶ As more development occurs, more changes to the floodplain result, and these 50-year probability estimates may then be invalidated (FEMA 1987, Riggs 2000)

⁷ Almost half of all U.S. tobacco production in the early 1990s was in Virginia, North Carolina, or South Carolina (Hart & Chestang 1996).

⁸ Two firms that participated in this research and one state agency reported paying for temporary hotel lodging for displaced workers.

CHAPTER 8

COMPARATIVE ANALYSIS OF THE SURVEY RESPONSES

Driving through the northern part of the study area, where the concentration of industrial and commercial establishments is greatest, reveals a varied mix of industry types present. Visually, those industries that require huge structures dominate the landscape. Manufacturing plants and warehouses for distribution and storage industries spread out over the landscape. Spatially smaller establishments are more often clustered on side streets and cul-de-sacs. The spatial requirements of some of these firms, however, are not always an indicator of a firm's number of employees. For instance, a trucking line or a company that services and repairs tractor-trailer rigs may have a relatively small work site, yet have more employees than a multi-warehouse operation. This chapter discusses the results of the survey (found in Appendix B) in terms of raw results and as comparisons among these results. The chapter is broken down into five major categories: General Description of Respondents, Disaster Experience and Preparedness, Floyd's Effects on Firms, Aid Seeking by Firms, and Top Priorities for Restoring Operational Capacity.

General Description of Respondents

A breakdown of the 41 usable responses by industry type reveals that Greenville's industrial district is quite diversified. This section describes the variety of employers within the study area that participated in this research. Their attributes are presented in the following order:

Industry Sectors, Firm Size and Operation Type, Primary Market, Age of Establishment, Potential for Site Expansion, Site Ownership and Disaster Experience and Preparedness.

Industry Sectors

Twelve separate industry sectors are represented in the study. The two sectors that dominate the results are manufacturing and wholesale operations. Eleven manufacturers across a broad spectrum of products participated in this research. Their products include fiberglass boats, jewelry, forklifts, pallets, and chemical products. On the other hand, almost all of the seventeen wholesalers sell goods to the manufacturers or the smaller supporting firms. Other wholesalers sell goods that support the local construction industry. For example, one wholesaler sold commercial restaurant equipment (Figure 12).

In fact, many of the other industry sectors reported in this research also support the manufacturers in the area. The firms engaged in leasing offered trucks of small to medium haulage to local companies. The repair and maintenance firm sent their mechanics, parts, and equipment to the customer's work site as part of their service. Some storage and distribution operators overlapped with the transportation and warehouse operators in servicing the temporary storage and delivery needs of local firms. Then again, some distributors operated completely independently of the rest of the industries in the region. One example is a regional distributor of eggs.

At first glance, having a health care sector establishment operating within the study area might seem inappropriate. However, the establishment that represents the health care sector is a physical therapy office that focuses on assembly line related injuries. By locating near the manufacturers, they can reduce the workers' time away from the job as they travel to and from the physical therapist's office. This "office" has a

waiting area seen in a traditional “doctor’s office.” In the back is a large, drafty room set up with numerous variations of conveyor belts and work benches. While I was being given the tour, one patient was being “retrained” on using a hammer so as to avoid repetitive motion injuries. Similarly, the provider of administrative services also works within the medical field. This firm is one of the medium-sized employers, and provides billing services for medical and dental practitioners around the state.

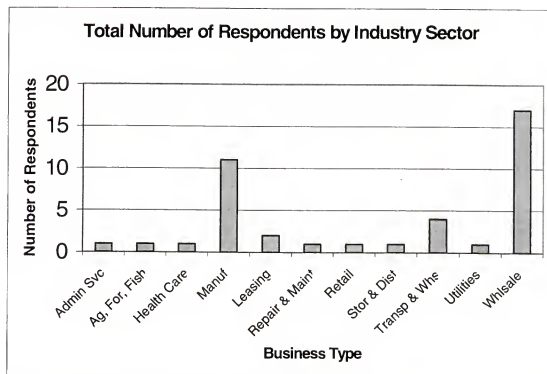


Figure 12—Total Number of Respondents by Industry Sector

Other somewhat unexpected industry sectors represented in the survey include a member of the agricultural sector. The agricultural respondent was a vertical integrator who has operated out of his location near the Tar River in the industrial district for decades. His coordination of activities among feed and chicken growers, shippers, processors and markets justify his establishment’s inclusion in this study. The retailer operates a national mail order distribution center of sporting goods. Although the retailer

does not produce these items, the firm requires extensive storage, shipping, and marketing activities. This particular employer is one of the largest in the county (PCDC 2001). Even though it primarily serves individuals and households, these are not primarily located in Pitt County, and are not likely to create an “artificial” economic boom to the local economy as part of the reconstruction efforts after the flood. Because of the sheer size of the firm, and its resulting economic benefits to local firms and citizens, it is included in the study.¹

One other entry among the respondents differs somewhat from the rest. The county’s utility provider was also located in the study area. Given its importance not only to the residents of Pitt County, but also to its businesses, this response was included in the analysis.

Firm Size and Operation Type

While a breakout of respondents is useful, another way to consider this group of participating establishments is by the number of employees at each firm (its firm size). Almost 83% (34 of 41) of the respondents had fewer than 100 employees (Table 16). An important consideration for this research is the resources that are available to a firm in developing its disaster response. For instance, an establishment with over 1000 employees has greater resources to draw on in coping with a disaster than does a firm with only 400 employees. In contrast, a firm with 15 employees may not have significantly greater resources than a company with 8 employees.

In contrast, the results obtained by both FEMA (2000b) and Wilson *et al.* (1999) in their studies conducted shortly after Floyd struck are segregated into three groups of firm sizes (1-9 employees, 10-99 employees, and 100+ employees).

Table 16—Detailed Breakdown of Firm Sizes of Respondents

Size of Responding Firms	Number of Firms	Percentage of Firms
Very small (<10)	14	34.1%
Small (10-19)	6	14.6%
Medium (20-99)	14	34.1%
Large (100-499)	4	9.8%
Very large (500+)	2	4.9%
Unknown	1	2.4%
Total	41	100.0%

Table 17 presents the firm sizes for the respondents in this study, using the three firm sizes presented in the two previous Hurricane Floyd studies (FEMA 2000b, Wilson *et al.* 1999).

Table 17—General Size of Participating Firms

Firm Size	Number of Respondents
Small (<10 empl)	14
Medium (10-99 empl)	20
Large (100+)	6
No data	1

For the rest of this report, the more general, three categories of firm sizes are used. In order to assess whether the numbers of small, medium, or large establishments in this study substantially differ from their relative numbers in the Pitt County economy, the following table was generated.

Table 18. Comparison of Business Impact Participants to Total County Businesses

Firm Size	Estimated # Firms in County	% of Firms in County	# Respondents	% of Respondents in Study *
Small (1-9 empl)	3291	79.7	14	34.1
Medium (10-99 empl)	793	19.2	20	48.8
Large (100+ empl)	47	1.1	6	14.6
No data	0	0.0	1	2.4
Total	4131	100.0	41	99.9

Source: FEMA 2000b, Wilson *et al.* 1999

* Note: does not sum to 100% due to rounding.

As can be seen, there are disproportionately more large employers represented in this study than there are in the Pitt County economy. Medium-sized establishments also appear in this study at more than double their ratio within the county. Lastly, small firms are far less prevalent in this research than their representation in the county economy. This is a result of the design of the study itself, which targets manufacturers and their supporting firms. The total number of firms within Pitt County includes all industry sectors, such as convenience marts and construction firms. Yet this study precludes the participation of those firms that market to individuals or households.

Just as two industry sectors comprised the majority of responses for a firm's industry type, the same is also true for a firm's type of operation. Together branch plants and independent operators make up 90% of the responses. There are twenty branch plants and seventeen independent operations. Only one franchise and one subsidiary participated in this study. Two respondents reported that they were some "other" type of operation, but did not elaborate.

Primary Market Area

There is a stronger variation in the primary market areas of the participants than is seen in their industry type and operation type. Although five of the 41 respondents listed more than one primary market area, four of them were all wholesalers with a statewide primary market. A statewide primary market was not an explicit option on the survey instrument, but was selected by choosing local market and markets elsewhere in North Carolina. The remaining respondent with double entries for primary market (a manufacturer) did not service "adjacent" market areas. In this case, the manufacturer primarily services local markets and markets in the southeastern U.S. (Table 19).

The local market dominates as the primary market, which is not unusual, given the number of survey participants that support the larger firms in the area. Eighteen (44%) of the participants indicated that they primarily serve the local market. Twelve establishments (29%) reported that their primary market was elsewhere in North Carolina. One example of this is a distributor of medical supplies to all of the hospitals located within the coastal counties of North Carolina. Those firms that focus on the southeastern U.S. market make up only 12% of the study group. A few of these five respondents reported that they focus their activities in the Coastal Plain Region of Virginia, the Carolinas, and Georgia.

Table 19—Primary Market of Respondents Based on Industry Sector

Industry Sector	# Respondents	Local	Other NC	SE US	Nat'l	Int'l
Administrative services	1	0	0	0	1	0
Agriculture, forestry, fisheries	1	0	0	1	0	0
Health care	1	1	0	0	0	0
Manufacturing	11	2	2	2	6	0
Leasing	2	2	0	0	0	0
Repair & maintenance	1	0	1	0	0	0
Retail	1	0	0	0	1	0
Storage & distribution	1	0	0	0	1	0
Transportation & warehousing	4	0	1	2	1	0
Utilities	1	1	0	0	0	0
Wholesale	17	12	8	0	0	1
Total	41	18	12	5	10	1

Almost a quarter of the responses (10) report primarily serving a national market; only six of these are manufacturers. At least one of the other manufacturers provides some of the assembled inputs required by a larger manufacturer located immediately next door. Others service smaller markets, either by providing inputs to other manufacturers (such as some of the textile producers), or by providing end products to local or regional distributors, wholesalers, or retailers. For instance, the line of merchandise developed by the jewelry manufacturer is designed solely for shops along the coasts. Each piece of

jewelry has a marine or beach motif. These are marketed directly to the boutiques and shops within the coastal towns of the Carolinas. Additionally, there was only one response indicating the international market as being the establishment's primary market. While some of the manufacturers are foreign owned (PCDC 2001), it is a wholesaler, not a manufacturer, which primarily serves an international market.

There are two other ways of considering the relationship between the primary market area and an establishment: by the size of the establishment, and by the establishment's operation type (Table 20). Generally speaking, there is a trend between the firm's size and market area. More small and medium firms have local markets. The number of small and medium firms decreases as the size of the primary market area increases. The largest of the firms are more likely to have a national or international primary market. An exception is the lone small firm that serves a national market. Large firms, on the other hand, report having very large market areas (national or international), excepting one that reported a local market.

Table 20—Primary Market Area by Firm Size

Firm Size	# Responses	Local	Other NC	SE US	Nat'l	Int'l	2 entries
Small (1-9 empl)	14	9	5	0	1	0	
Medium (10-99 empl)	20	8	6	6	4	0	
Large (100+ empl)	6	1	0	0	4	1	
No data	1	0	0	0	1	0	

A similar inverse relationship between the size of the primary market area and the number of respondents is seen with branch plants in the study. Eight branch plants primarily serve a local market. Actually, two of these branch plants reported serving a statewide primary market by virtue of having selected two adjacent primary market areas on the survey. The third branch plant that chose two primary market areas selected local and national. The remainder of the state serves as a primary market for only three branch

plants. Another three branch plants reported either a southeastern region or national market area.

One of the independent operations (and one described as some “other” type of operation) also selected the entire state as its primary market area. Despite this, there is a relationship between the primary market area and the number of independent firms responding. Like branch plants, eight independent establishments selected a local primary market. The next highest number of responses given by independents was for a national market area (six responses). Three indicated primarily serving a market elsewhere in the state, and only one has a primary market in the southeastern states (Figure 13).

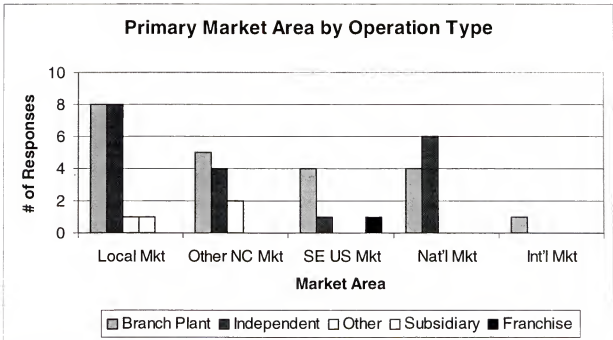


Figure 13—Primary Market Area by Operation Type

Age of Establishment

The industrial district used in this study has been under development for decades. Some of the oldest manufacturing facilities started up during the Vietnam War. On the other hand, recent years have seen substantial economic growth through the expansion of

Greenville's industrial base (PCDC 1999) (Table 21). Indeed, some facilities visited as part of this research were ineligible to participate as they were still under construction in 1999.

As can be seen, over one third of the respondents set up shop in the study area in the last five years. Between 1986-1995 another 40% of firms began operating out within the study area. Yet the eight most established enterprises have been in the study area over twenty years. Despite the age of these establishments, they seem satisfied with their site's ability to accommodate any future growth.

Table 21—Respondent's Number of Years at the Study Site

Number of Years at Site	Number of Firms	Percentage of Firms
1-5	15	37%
6-10	8	20%
11-15	8	20%
16-20	1	2%
20+	8	20%
No data	1	2%

Table does not sum to 100 due to rounding.

Potential for Site Expansion

Only seven respondents reported that their site's potential for expansion was either poor or unsatisfactory. Since it is possible that this may be related to the age of the establishment, Figure 14 compares these two variables. The oldest establishments (16 or more years) do not indicate that their site is deficient with respect to its potential for expansion. Younger ones more often rate their sites as either poor or unsatisfactory in terms of expansion. Perhaps this is an indicator of the growing pains of these younger firms. It is possible that concerns about site expansion may, in some cases, contribute to the permanent relocation of a firm after a disaster strikes. Another possible factor that may influence a firm's postdisaster location decision is if the firm owns the site.

Firm Age and Site Expansion Potential

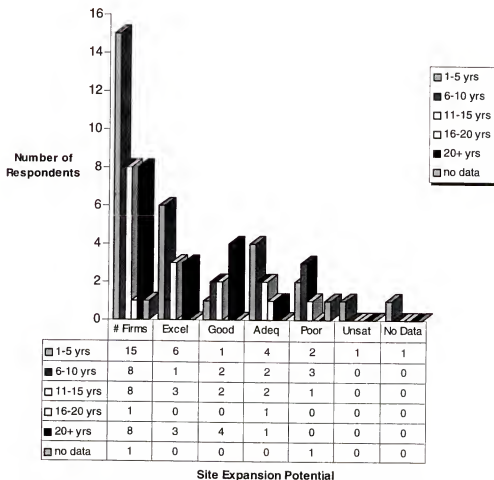


Figure 14—Firm Age and Site Expansion Potential

Site Ownership

Ownership of the site may discourage relocation, especially as businesses (other than providers of rental housing) are not entitled to participate in the government's "Buy Out" Program. On the other hand, difficulty between a landlord and tenant over the speed, quality, and cost of the structural repair may encourage (or even force) the tenant to relocate elsewhere. Table 22 compares site ownership to operation type. Almost 42% (17) of the respondents reported that they did not own their business site. On the other

hand, roughly 25% of respondents that own their site were either independents or branch plants (24%, and 27%, respectively).

Table 22—Site Ownership Based on Operation Type

Operation Type	Own	Lease	No Data
Independent	10	7	0
Franchise	0	1	0
Branch plant	11	8	1
Subsidiary	0	1	0
Other	2	0	0

The previous two characteristics (site expansion potential and site ownership) are presented in order to introduce some of the possible ways in which general traits may influence a firm's postdisaster outcome. However, they do not include consideration of a firm's previous disaster experience or its general disaster preparedness. These are presented in the following section.

Disaster Experience and Preparedness

Because of problems with the survey instrument (as discussed in Chapter 4), the only natural hazard that can be included in this discussion of disaster experience is that of hurricanes. The participants were asked how many hurricanes the establishment weathered between 1995-1999. Many could not remember them all. As one reported, "there's been so many recently." Six official hurricanes passed through Pitt County between 1995 and 1999. Half of the respondents reported going through all six. Some of the "younger" establishments had gone through fewer storms (Figure 15). As per the discussion in Chapter 6, the convergence of three hurricanes in 1999 was unlike any single storm that had ever hit the state.

Quite often, insurance coverage is obtained in order to provide a safety net in case of an unexpected emergency. Within the commercial sector, insurance coverage may be a

requirement of a lending institution. Conversely, less capital-intensive firms may forego insurance coverage in an effort to cut corners. Shortly after Floyd struck the state, Wilson *et al.* (1999) developed a detailed estimate of the type of insurance coverage that firms possessed. This was based on the responses to an extensive survey questionnaire.

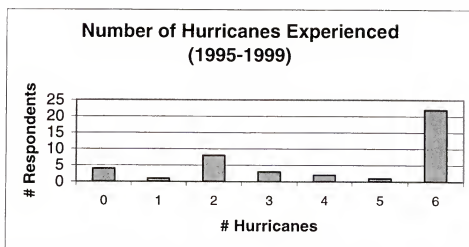


Figure 15—Establishment Experience with Hurricanes (1995-1999)

According to their research, 83% of small firms had some type of insurance coverage. Most of these respondents carried either liability, casualty, or fire insurance, or some combination of them. All large firms had some form of insurance. Medium firms fell somewhere in the middle of these two groups in terms of insurance coverage. Lost revenue and flood insurance were not extensively carried. Again, large firms were more likely to have this coverage, but smaller percentages of them did so (Table 23).

Participants in this study were asked if they had adequate insurance coverage to address the damage caused by Floyd. They were also asked if they had business interruption insurance. Two thirds reported that their insurance coverage was adequate; 44% reported possessing business interruption insurance. As one interviewee pointed out, though, business interruption insurance can be nullified if a flood is the cause of the

interruption. Therefore, business interruption insurance may be beneficial in other types of disasters, such as earthquakes, but it may not benefit firms in cases of flooding.

Table 23—Average Level of Insurance Coverage by Firms in Eastern North Carolina

Type of Coverage	Small Firm	Medium Firm	Large Firm
Any	83%	91%	100%
Liability	84%	88%	83%
Casualty	79%	84%	83%
Fire	75%	80%	83%
Lost revenue	21%	33%	54%
Flood	13%	17%	36%

Another way in which companies can prepare for a disaster and its aftermath is by developing a disaster plan. Almost one third (32%) of participants had a disaster plan in place before Floyd. Of those 13 establishments, ten reported that it was adequate to meet the needs of the firm during the recovery period, seven of these ten were interviewed. Five of the seven did not sustain any flooding inside their buildings. The other two found more than a foot of floodwater in its structures. This “maximum” damage demonstrated to one establishment that their disaster plan was adequate; at the other it proved just the opposite.

In fact, a Human Resources Director reported noticing a “disaster preparedness checklist” published every summer in a monthly magazine for human resources professionals. She is not certain if these checklists appeared as a result of Floyd, or if they appeared prior, and she simply had not paid close attention to them. She admitted that today, however, she scrupulously goes over every item on the checklist to ensure that her firm’s disaster plan covers it. Figure 16 presents a comparison of the adequacy of insurance coverage, the possession of business interruption insurance, the possession of a disaster plan among respondents, and the adequacy of those plans.

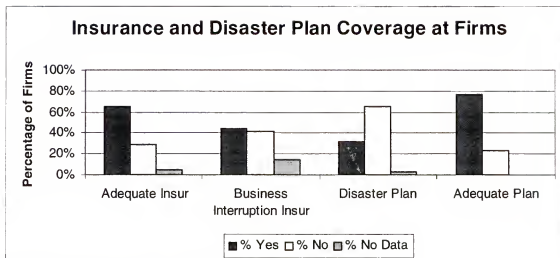


Figure 16—Insurance and Disaster Plan Coverage at Firms

These elements of disaster experience and preparedness are two factors that may influence a firm's postdisaster outcome. The following section presents the effects of Floyd on the participating businesses.

Floyd's Effects on Firms

The questions regarding the impacts suffered by firms due to Floyd can be grouped into three broad categories. Relocation Concerns, Disruption to the Firm, and Changes to the Firm. Each is discussed separately.

Relocation Concerns

Despite the extent of floodwaters in the study area, only 13 of the participating establishments relocated their operations because of Floyd. All of these relocations were temporary. Two respondents had permanently moved their operations to their current site only months before Floyd struck. While they suffered no flood damage at their new location, another respondent did not fare as well. This particular firm was in the process of building a new, larger facility outside of the study area. The structure was well

advanced in its construction when Floyd hit. The firm suffered a loss greater than just the damage to the new facility. This firm's market (for recreational watercraft) was undergoing a slowdown that has increased in the years since 1999. The only "good news" for this firm was that its Greenville facility was not severely damaged, although much of its inventory was.

Nine of the thirteen respondents that had to temporarily relocate did so for two weeks or less. Generally speaking, in most areas of the industrial district it took 10-14 days for the floodwaters to completely withdraw. Another facility relocated for just over three weeks. On the other hand, three establishments were displaced for more than a month. Each of these extended relocations was due to problems associated with renovating their facility. In fact, two of these renovations required more than 60 days to complete (Table 24).

Table 24—Length of Temporary Relocation of Firms

Number of Days Relocated	Number of Firms
None	28
1-7 days	5
7-14 days	4
15+ days	4

Another two respondents indicated that they did not have to relocate their entire operation, but they did find a new site for part of their activities. One small manufacturer had its manufacturing activities disrupted by the flood for a short time. It relocated its production activities for five days. The other firm that moved part of its operations was a small hardware distributor that housed its inventory and logistics activities in a warehouse close to the river. This firm waited six months to elapse before the warehouse was functional again.

One of the goals of this research was to examine the extent to which business networks influence the location decision of establishments. For this reason, two questions were included in the survey. The first asks if the responding firm's decision to remain in the study area influenced the location decision of any of the firm's business partners. Somewhat surprisingly, all of the respondents said no. This may reflect a lack of embedded business networks in the study area, as there are few establishments of similar business activity. Or it may be an indicator of Greenville's strength as a regional economic center. On the other hand, it may also be a case of too few respondents. After all, 28 respondents did not relocate at all. Excluding one of the temporary movers, all of the remainder moved just across the river, to locations in within the city limits of Greenville. Because the city has regulatory control over the industrial district; therefore, this is considered to be a move within the same jurisdiction. Only one respondent of the 13 that relocated moved to a site that fell under a new jurisdiction (Pitt County) (Figure 17).

In a few cases, respondents elaborated on this move during the interview. Finding a suitable site for their temporary operations was often constrained by the short time frames, and transportation problems involved. In addition, zoning restrictions also factored into the suitability of a site. Some respondents reported "borrowing" or "sharing" space from other firms. The providers of the assistance were residential neighbors, friends, and in one case a competitor. The sharing of business space with a competitor in an effort to help the competitor survive the setbacks from Floyd does suggest network behavior. Other respondents set up a second or "field" headquarters in hotel or community college conference rooms. These were the larger firms in the study

(500 or more employees). They did not consider this as a temporary relocation of their actual headquarters. These field headquarters focused on disseminating information to affected employees and coordinating the establishment's relief efforts. This relief activity took two different forms:

- addressing the survival and recovery needs of employees and their families, and
- assisting the city and affected communities throughout the region with their recovery efforts.

The employee survival issues are discussed in the next chapter. But the community support efforts deserve a brief mention.

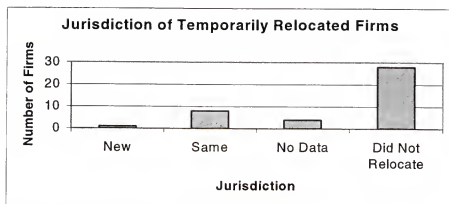


Figure 17—Jurisdiction of Temporarily Relocated Firms

On top of addressing their own “corporate survival” issues, the firms in the study area adopted a strategy of trying to assist in the survival efforts of their own staff as well as affected residents throughout the Coastal Plain as best they could. Some donated *gratis* their own products. In the case of one manufacturer of mops, buckets, and sponges, this donation required eight months of overtime to make up. Yet the Human Resource Director did not express regret. Instead he proudly reminded me that all items used in cleaning up the residue from the flood had to be discarded after each use. Each cleaning exposed the mops, sponges, and other cleaning supplies to contaminants that were

hazardous to human health. Furthermore, flood cleanup required at least two separate scrubbing sessions (at least 24-48 hours apart). This was necessary to let any residual toxic mold or mildew appear and be scrubbed away before the structure could be declared safe for human occupancy. The cleaning materials used in each round of cleanup were too contaminated for use in subsequent rounds of cleaning. For households that lost everything, the cost of cleaning supplies (especially under such high demand conditions) could represent a major drain on the family's already strained finances.

Donations of products were not the only manner in which local firms supported the relief efforts in the Coastal Plain. They also provided financial contributions as well. The following table presents the financial donations offered by firms throughout the Coastal Plain in the wake of Floyd. This data is compiled from Wilson *et al.* (1999).

Table 25—Firm's Participation in Community Assistance in Eastern North Carolina

Estimated	Small Firm	Medium Firm	Large Firm
Firms aiding communities	55%	66%	63%
Avg value of firm's support	\$1500	\$17,800	\$81,500

Source: Wilson *et al.* (1999)

Of course, not every firm in the Coastal Plain suffered setbacks in the wake of Floyd. Some actually benefited financially. These are primarily those firms involved in reconstruction or repair work, such as home or auto repair. The retailers and wholesalers of replacement household goods (such as appliances) may see an upswing during the disaster recovery period too (Guimaraes, Hefner & Woodward 1993; West & Lenze 1994).

In terms of networks and firm location decisions, if the respondents did not influence their business clients, did their clients influence them? This was the second question asked on the survey in order to examine what, if any, is the relationship between

networked firms and postdisaster relocation decisions. Four respondents did reply that their customers influenced them. Unfortunately, these questionnaires were either picked up or mailed in. As a result, no interview was conducted in order to draw out the manner or method in which clients' location decisions influenced the respondent. What is known is that two of the four respondents were wholesalers (with four and eleven employees, respectively). Another client-influenced respondent operated a 21-man transport and warehouse establishment. It is easy to see how these three respondents could be influenced by their clients' location decisions. The fourth respondent is the most intriguing: it is one of the very large, independent manufacturers (with more than 500 employees). One can only speculate as to the nature of the clients that influenced its decision to remain in Greenville.

Disruption to the Firm

In order to assess the extent of disruption a disaster causes a firm, a list of seven internal and external business elements was developed. Survey participants were then asked how many days disruption their establishment suffered according to the level of damage each element sustained. They were then asked to rate the degree of damage on a 1-to-5 scale (from none to extreme) incurred for each element on the list. Since respondents skipped those elements that did not seem appropriate to their establishment, or for which there was no disruption, none of the elements has 41 responses. Examples of inappropriate business elements include assembled inputs or rail services for a provider of administrative services. Table 26 reports the average and median number of days that participating establishments were disrupted after the flooding of 1999.

Table 26—Average and Median Number of Days Disruption Due to Business Element Difficulties

Business Element	Average Number of Days	Median Number of Days
Roads	10.8	8.3
Equipment	21.4	7.0
Staff unavailable	8.3	7.0
Building	11.5	6.0
Electricity	11.2	6.0
Communications	7.6	6.0
Raw material	26.3	5.5
Management unavailable	6.6	5.5
Inventory	35.3	5.0
Railways	5.2	3.0
Airports	9.4	2.5
Assembled inputs	5.5	1.0
Financial services	2.6	0.0
Ship transport	1.9	0.0

Wilson *et al.* (1999) reported that across the Coastal Plain as a whole, road closures and loss of water and electricity caused the most prolonged impacts to firms. However, they did not include staff shortages and survival issues in this assessment. Results presented later in this chapter demonstrate that staff availability was a more significant concern to businesses than water or electrical service. Additionally, their study reported that businesses in severely impacted counties, such as Pitt County, were shut down roughly 4-9 days. Small firms were most likely to remain closed the longest, while the opposite was true for large firms.

The results from this study indicate that while road closures and loss of electricity played a significant role in business disruption, so too did the damage to buildings, and equipment, and, even more to inventory and raw materials. However, the problem with assessing averages is the inclusion of outliers. Each of these internal business elements has at least one pronounced outlier. Actually this is true for every business element that averaged nine or more days disruption because of Floyd. Take raw materials as an example. The vertical integrator in the broiler industry that participated in this study

factually reported that it took one year (365 days) to officially replace its destroyed raw materials—several tons of corn. Both the corn in the silo and in the fields were destroyed. In the interim, corn and other poultry feed was purchased and shipped in from midwestern states so that those broiler producers that did not lose their chickens to the flood could feed them. Removing this entry from the averaging process might make mathematical sense, but it strips away some of the prolonged difficulties incurred after a disaster. Likewise, another respondent whose management representatives frequently fly cross-country to corporate headquarters was affected by the closure of all nearby airports due to flooding. Table 27 clarifies the potentially disruptive effects of these internal and external business elements.

Table 27—Detailed Breakdown of Duration of Business Disruption Due to Business Element Difficulties

Business Element	0 days	1-7 days	8-14 days	15-30 days	31-60 days	60+ days	Total
Roads	0	16	19	3	1	0	39
Staff unavailable	1	21	12	2	0	0	36
Communications	4	19	6	4	1	0	34
Building	9	11	6	3	2	1	32
Electricity	2	21	5	2	0	2	32
Mgmt unavailable	6	14	9	2	0	0	31
Equipment	11	5	7	2	2	3	30
Inventory	7	9	6	2	0	2	26
Raw material	5	7	4	2	0	1	19
Financial services	10	5	2	0	0	0	17
Airports	8	5	2	1	0	1	17
Rail	7	5	3	1	0	0	16
Assembled inputs	7	3	3	2	0	0	15
Ship	6	3	1	0	0	0	10

As can be seen, although not all businesses suffered disruptions from these elements, some elements were cause for significant concern. During the first week after the flood, the three biggest issues were staff availability, electricity, and communications systems. (One interviewee reported how elated he was when he found out that he could transmit a computer-originated fax via his cell phone). Three other important issues were

roads, management and damaged buildings. Unlike the impression given in the table of averages, damage to materiel (inventory, raw materials, and equipment) were much farther down the list in terms of immediate importance, as was airport service.

Staff availability and road closures were still important issues two weeks after the flood. This is in keeping with the time needed for highway workers to finish the preliminary repairs to roadways. It also reflects somewhat the time-consuming difficulty residents faced in order to restore some normalcy to their lives before reporting back to work. This interim no doubt also reflects the efforts of some employers to directly assist employees in addressing their survival issues. This is discussed in more detail in the following chapter.

In contrast, management, staff, and infrastructure issues (other than air travel) do not appear to be prolonged issues. This may be an indicator of the economic importance of these three items to business, in so far as they can be resolved quickly by either the private or public sector. On the other hand, some establishments clearly suffered such drastic damage to their buildings and material that they suffered a prolonged setback because of it.

Or did they? Relatively speaking, the setback suffered from a short, but geographically intense series of road closures could prove more damaging to a firm than the loss of an inventory that requires a year (or deep pockets) to replace. Figure 18 illustrates the degree of severity of disruption for respondents according to each business element. Since the five categories of severity (none, minor, moderate, severe, and extreme) are not of equal value (as the hours in a day are of equal value), the severity

categories cannot be averaged. But they can be combined into two groups: Less than Severe, and Severe or Extreme.

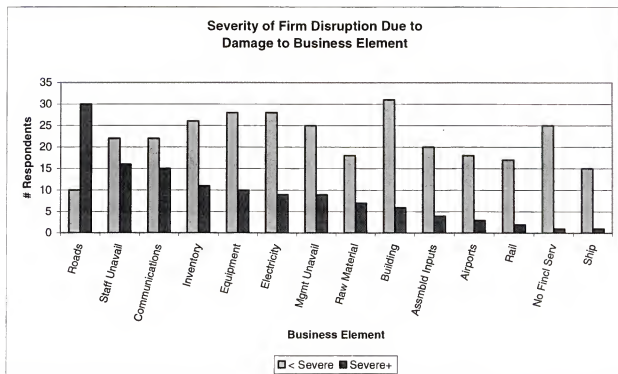


Figure 18—Severity of Firm Disruption Due to Damage to Business Element

This comparison of business elements indicates that disruption of roads, workforce, and communications had the most significant impact to businesses. Yet Floyd impacted businesses in a variety of ways, and to differing degrees. In some cases this resulted in changes to the firm itself.

Changes to Firm

There are three ways in which surviving firms can change as a result of a disaster (other than relocation, which was discussed earlier). These changes include: altering the scale of their operations, changing the number of employees, and changing the customer base.

A few establishments did increase the scale of their operations after Hurricane Floyd. In the case mentioned earlier, this expansion was already underway when Floyd hit. It was also in response to earlier market trends. What this research does not uncover, however, are those establishments that expanded in order to replace capacity lost at other facilities destroyed by Floyd. Some establishments in the city of Rocky Mount were so destroyed by the floods that the headquarters permanently closed the Rocky Mount facility, and expanded operations at other facilities in the state (Wenger 2001). In Greenville, more than half of the establishments remained operating at the same scale. Eleven respondents acknowledged a decrease in scale, although one pointed out that this had been planned earlier in the year; it was not a result of the disaster (Figure 19).

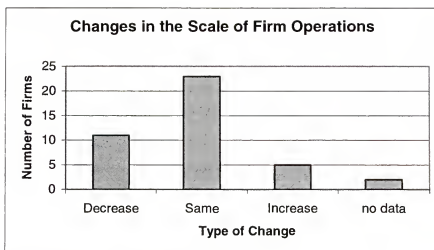


Figure 19—Changes in the Scale of Firm Operations

With respect to firm size, or the number of employees, six months after Floyd most establishments were at the same size as before the hurricane. Of course, some manufacturers had added temporary (short-term) staff in the months following Floyd. This was done to complete backorders. It also supplemented the workforce so affected employees could take time to restore their households and lives. But initially, medium

and large employers across eastern North Carolina lost 3-8 employees immediately after Floyd (Wilson *et al.* 1999). It is unclear whether these people were laid off, fired, displaced, or unable to be contacted by the employer. Table 28 reports the firm size of participating firms in this study for two different time periods: six months after Floyd (March 2000), and at the time of the data collection in June 2001 (21 months after Floyd).

Table 28—Changes in Firm Size between March, 2000 and June 2001

Firm Size	Size on 06/2001	Increased Size since 03/2000	Same Size since 03/2000	Decreased Size since 03/2000
Small (1-9)	14	0	14	0
Medium (10-99)	20	5	15	0
Large (100+)	5	1	5	6
Unknown	1	0	0	1

Small firms saw no change in employment levels during the period between March 2000, and June 2001. Large firms decreased their employment levels, and medium sized firms increased them. Yet it is unknown if these changes offset each other in terms of total employment for the area. In other words, the study does not indicate whether the number of jobs added by medium firms is equivalent in any respect to the jobs eliminated at the large firms.

A more telling change to the firm is the changes in its client base. Close to half of the respondents did not answer these survey questions. It is not known if the question was too intrusive, or if the establishment simply had no change in its client base. Of those that did respond, nine firms gained customers and 14 lost customers (Figure 20). During the interviews it became clear that those very small firms that chose to close while the floodwaters were present suffered from the continuing competition within the marketplace. Long-standing customers were lost because some other establishment was able to fulfill the customer's needs while the affected firm was closed. Despite

expressions of sympathy from the customer, the respondents felt as if the loss of the client was permanent. This sentiment was most strongly expressed if the lost customer was affected by the flood, but continued or quickly resumed operations afterwards.

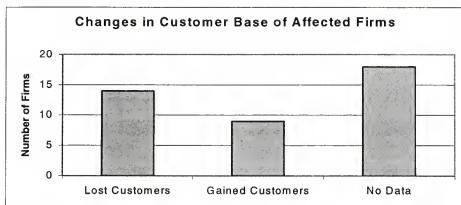


Figure 20—Changes in Customer Base of Affected Firms

Conversely, almost all of those firms that gained customers reported that it was their determination to keep operating despite the setbacks caused by the flood that increased their business. They gained a reputation of being reliable regardless of circumstances. One business owner reported that one client was so appreciative of his efforts to supply this client, despite four feet of polluted floodwater on the roads into and out of his property, that the client made several referrals to the responding firm that resulted in new business.

Many of the factors discussed in this chapter demonstrate the variety of ways in which a business establishment can suffer a setback after a disaster. The next section discusses those firms that requested assistance in their economic recovery efforts.

Aid Seeking by Firms

Given that the government is viewed as the lender of last resort, the survey asks if the business was able to absorb the costs associated with the disaster without

nongovernment loans. Four respondents indicated that they did need to obtain a private sector loan to help in their recovery process. A few small employers were quite forthright in expressing their gratitude to their local banker for providing them with an additional loan. Many others (35) did not require financial assistance at all. Additionally, none of the respondents asked their business association, the city, or any nongovernment organizations (NGOs) for financial or technical assistance. However, there were a few state NGOs in the region providing no-cost consultations and assistance in obtaining federal aid (Fitts 2001). In fact, the North Carolina Rural Economic Development Center reported that most of their clients were small, independent (1-person) operations with limited expertise in completing the variety of documentation necessary for an application for federal aid. In fact, most of these businesses were farms, doctors, or lawyers.²

In contrast, there were six respondents that requested financial assistance from the federal government. Although only four respondents said that they needed government aid, while six requested it, two respondents applied for government assistance in addition to obtaining a private loan. A possible explanation for this is that the government aid took so long to be disbursed that a bank loan was obtained in the interim. Of the six requestors of aid, five actually received it. Furthermore, two of these six requestors also requested and received aid from the state. Although this aid can take the form of either low-interest loans or grants, it is usually disbursed as loans. For heavily indebted firms, an additional loan can be a mixed blessing. Four of those firms that received federal aid, and both that received state aid, said the money was helpful. The remaining recipient disagreed. One aid-receiving firm reported that the money influenced its decision to remain in Greenville. The others were not so influenced.

Two respondents also reported receiving technical help from the Environmental Protection Agency (EPA). These two examples are provided to illustrate the behind-the-scenes efforts required by managers, resource managers, and others in addressing recovery needs after a disaster. Both respondents indicated their surprise at the professionalism and lack of bureaucratic hassles observed while obtaining assistance. One respondent was the vertical integrator. All of the structures and vehicles at his establishment were tested for the variety of pathogens present in the floodwater. Because this integrator works directly with a major national food producer, that national firm sent its own team of toxicologists to conduct its own study as well. The integrator was immensely relieved when he learned that both studies reached the same conclusions regarding which structures and vehicles should be demolished and which repaired. The reports also included guidelines and standards on how to repair and sanitize the remaining structures and vehicles. Since the storage facilities and vehicles would, in the future, again contain products for eventual human consumption, follow-up toxicology evaluations were also conducted.

The second respondent that worked with the EPA required their permission in having some other establishment's underground diesel storage tank removed from his property. Apparently, the tank was almost empty as the floodwaters rose. The ground above and around the tank became so saturated with rainfall that the soil began to essentially drift apart and wash away. The volume of air in the tank allowed it to float not only to the surface of the ground, but also along the countryside on the current moving the floodwaters. As the floodwaters receded, the tank was deposited right at the fence line of a distributor of industrial equipment. Under more ordinary circumstances the firm

would have been responsible for removing the debris and testing of the ground for contamination. As it turned out, because of the extreme number of environmental hazards in North Carolina associated with the flood of 1999, the EPA instituted a “no questions asked” policy for hurricane cleanup problems. The respondent with the wayward diesel tank simply called the EPA hotline, which was established solely for Hurricane Floyd-related calls. The EPA sent out one contractor to retrieve the tank, and another to test the area for potential contamination. The respondent was not required to fill out any forms or pay any fees or fines.

Up to this point the results presented were those criteria deemed important at the outset of the study. The final section of this chapter presents those criteria that *respondents* felt were most important.

Top Priorities for Restoring Operational Capacity

The final question on the survey asked respondents to write down “the most important thing(s)” that put the firm back into operation at normal levels after Hurricane Floyd. Several respondents asked for clarification, at which point I replied, “What was it that was most important to getting back to 100% operations? Was it repairs, roads, phones, or what?” Six of the surveys (which were picked up or mailed in) did not have an answer to this question. Of the 35 participants that did answer, 24 of them provided two criteria, and three provided three separate criteria for restoring operations.

As can be seen in the graph below, roads were a top priority for almost 25% of the respondents (Figure 21). Employee issues and management issues were also frequently reported. Employee Issues refers to getting employees back to work. Management Issues

is a catchall category that includes all of the management concerns and decisions that were not always addressed in the survey. This includes, but is not limited to:

- Addressing safety issues (e.g., polluted floodwater residue, downed power lines, and wildlife, such as snakes, in the facility)
- Damage assessment
- Allowing time off for employee recovery
- Adding extra employees to catch up with backlog of orders
- “Gaining access to flooded customers”
- “Teamwork”
- “Support from corporate headquarters”
- “Keeping in touch with the weather”
- Customer service
- “Trying to decide what to do first—overwhelmed”

The list is not in any particular order. However, the some items are direct quotes from survey responses. The last item illustrates how difficult decision-making can become for a very small firm where all of the employees look to the boss for leadership.

The response category of Temporary Facility was created for those three responses that referred to setting up a temporary office or workspace. Also infrequently cited were the infrastructure issues of electricity and telephone service. Similarly, facility repair and insurance were only mentioned once as a top priority.

The next most important factors listed by respondents followed in much the same way as the ratio of the first priorities. Roads were reported most often as a second item of importance. This was followed by reports of employee issues, management issues, electricity, and phone service in equal numbers. A temporary facility was reported twice

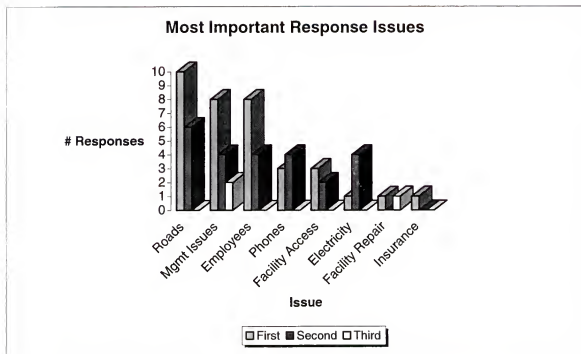


Figure 21—Most Important Response Issues

as being of secondary importance. Of the three respondents that listed a third factor, two reported management issues, and one reported repair of the facility to be important to the firm's recovery.

These factors for business recovery lend support to the conclusions reported earlier that employee issues and accessible roads are of paramount importance to firms after a disaster. This question also demonstrates that there are a variety of issues that face managers in the wake of a disaster. It is important to keep in mind that all of the items listed by respondents to this question address a subtle timescale that is not closely scrutinized in this research. The most important criteria for business recovery focus on "must fix fast" items. Without them the business will fail. With them the business may still fail to thrive, but at least it is still functioning. In order to fully return to predisaster

levels of “operational normalcy,” considerations of lost inventory, damaged or destroyed equipment, and structural damage must all be addressed eventually as well.

Another shortcoming of the analysis of this question is the assumption that responses are listed in priority order. However, some or all of them may be of equal priority to the respondent. While the interviews were originally intended to provide some clarification of this concern, they developed into a most remarkable source of insight into postdisaster business management dilemmas and decisions instead. The results of these interviews are presented in the next chapter.

NOTES

¹ These benefits may include the out-sourcing of construction to expand its warehouse and office facilities, maintenance of its fleet of trucks, mailing of its catalogues, and the hiring of two hundred residents of eastern North Carolina (PCDC 2001).

² The service professionals saw such a drop-off in their business in the early months following Floyd that they could not make the expensive financial payments required for their businesses, such as malpractice insurance premiums for physicians. Although this reduction in patrons ceased over time, the sudden revenue loss was more than some professionals could financially accommodate. Apparently, the local citizens were too busy putting their lives in order, and later working multiple jobs, to take time off to engage in professional services during the recovery period after Floyd.

CHAPTER 9

POSTDISASTER BUSINESS RESPONSE: INTERVIEW RESULTS

I consider myself extremely lucky; I did not experience Hurricane Floyd in person, but I was permitted to interview 28 business owners or senior managers who did. Each one had an amazing story to tell. Some even provided pictures and corporate newsletters to supplement their conversations with even more detail about the disaster and their recovery. And despite the geographically small area of selection for participants, or the various similarities in their establishments, no two people told the exact same story. In other words, no two establishments experienced the flooding and its aftermath in the same way. Having made this caveat, this chapter first presents the results of the two categorical variables that were able to be created and coded based on the interview data (Levels of Management and Degree of Flooding). These two sections are followed by two more extensive sections that discuss those impacts that required managers to make tough decisions: Employee Suffering and Firm Difficulties.

Levels of Management

Technically speaking, this variable could be created based solely on a visit to each firm. However, it was the 28 interviews that demonstrated the value of this variable to the research. So the remaining 13 respondents were coded based on the organizational structure observed during the visit to drop off or pick up questionnaires. There are thirteen establishments with the smallest organizational hierarchy; these have only one

“boss” to go to for leadership decisions. Typically, the boss is the owner, but in several cases he is the regional or general manager. These establishments were coded as ‘owner’ to indicate that only one level of management is available.

A second group of thirteen participants are also very “hierarchically limited” establishments. These organizations have one “head boss” and at least one subordinate with some degree of decision-making authority. However, this authority is delegated and limited. Most of the authority of the subordinate manager revolves around his or her capacity to supervise staff. For this study, establishments with these subordinate supervisors are categorized as Foremen. In many of these establishments, these subordinate leaders are indeed foremen. They have the authority to make specific decisions within their “domain” such as sending a two-man crew instead of a single service representative out to a client’s site, or deciding in which part of the warehouse to store incoming goods. These individuals lacked the authority to negotiate contracts on the establishment’s behalf. Consequently, questions regarding “senior management concerns” are referred back to “the boss.”

There may be some error in the coding of some respondents that fall into either of these categories (owner or foremen). This coding relies on the subjective judgment of the researcher. On the other hand, at establishments with only five or six employees, the levels of management are easy to ascertain. It is those firms with 30-40 employees that are harder to determine. In cases where an interview took place, interruptions to the interview were discretely overheard in order to determine the degree of delegation of authority at the establishment. If the interviewee (usually the owner, regional manager, or general manager) at these smaller middle-sized establishments provided guidance on the

most mundane tasks (e.g., going to pick up parts or supplies at a vendor, or deciding when off-site work crews should report in the next day), then it was assumed that there was no intermediary, such as a foreman or other low-level manager, to fulfill these tasks. Of course, it is possible that the foreman was on vacation, as the interviews were conducted in June, 2001; thus, the potential exists that the numbers of respondents within these two categories are not precise.

Discriminating between these two categories may not seem of great importance, but the presence of low-level decision-makers allows for some degree of flexibility and adaptability in response to change. The trust engendered between junior and senior decision-makers can facilitate a more rapid response to changing circumstances. In the aftermath of a disaster, it also allows for a more complex disaster response to be developed by the establishment (which is illustrated later in this chapter).

The third category for levels of management was the easiest to determine. Those establishments with sophisticated internal hierarchies in which the establishment has one or more subordinate managers onsite with decision-making authority are entered into the data set as Directors. These subordinate managers typically have a well-defined authority to make some types of decisions on behalf of the establishment. Their job titles often included the word "director." The largest of employers have Directors of Personnel, Maintenance, Marketing, and/or Sales. At smaller firms there may only be a Regional Sales Director. Because these managers are entitled to negotiate contracts (or similar decision-making authority), they allow the senior-most employee (the boss) to delegate some of the firm's disaster-response duties to these managers. This, in turn, frees the boss to undertake additional disaster recovery activities. There were 15 participating

establishments in this study with this higher level of management onsite when Floyd hit (Figure 22).

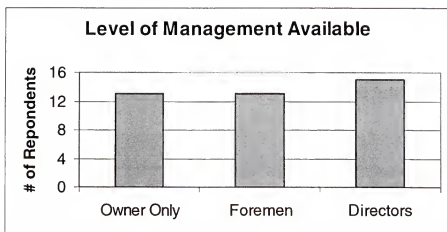


Figure 22—Level of Management Available at Responding Establishments

Although there is some degree of balance in these three categories within the response pool, this is not true for the amount of flooding that each respondent's site received.

Degree of Flooding

This variable was developed entirely from the interviews, and almost purely by accident. The first establishments visited were located at perhaps the lowest elevation in the entire study area (on Greene Street, near the Tar River). A map of the study area is available in Chapter 4. As it turned out, the very first firms visited were so severely flooded (with seven or more feet of water in the buildings) that there were indicators of this in the lobby, the work area, or on the building's exterior. These included framed photos of the site while inundated, a line painted up near the ceiling throughout the workspace to indicate the height of the waterline, or discoloration of the exterior from floodwaters.

As interviews took place at establishments that suffered little or no flood damage, my curiosity would get the better of me, and I would ask how much flooding the site received. Invariably, those whose buildings flooded would not require any prompting. Severe levels of flooding are a badge of honor for some, and an unhealed scar for others. Those that experienced little or no damage almost never volunteered this information, unless they were offering it as an excuse to forego completing the survey. If I could get them talking a bit, then most of the time they could be persuaded to complete the survey anyway.

Had I begun this research along any other thoroughfare that leads into the industrial district, I would not have collected this information as completely. At no other point along the arteries leading into the study area are so many affected firms in such close proximity. It was only after having heard and seen the damage at the first four or five establishments visited, that convinced me that this might prove to be useful information. In fact, it is not uncommon along the eastern edge and northern interior of the study area to discover one flooded firm alongside two undamaged firms, or vice versa. And the levels of flood damage sustained varied just as much.

Once this information was examined, a clear division into five categories of progressively greater coverage of floodwater could be developed. The first (Access Road Only) represents those establishments whose land or buildings were not flooded, yet they could not reach their facility due to flooded roadways. These include the thoroughfares into the industrial district, driveways or property access roads. These establishments suffered no structural damage, nor any deposition of debris on their property. Eleven respondents were fortunate enough to fall into this group. The second category is

composed of those establishments that had some floodwater on their property, but not enough to damage any equipment or material stored outside. This group is called the Unused Land category, as the land that was flooded was most often the “green space” on the property that was not used for any commercial activities. For instance, floodwaters tended not to reach the building or the rear storage yard if the property was sloped. In a few of these cases, there was minor flooding of the outside storage areas, but not the building. This flooding was only a few inches in depth. It was enough to leave a waterline on the tires of vehicles, but not enough to damage externally stored vehicles, equipment, or inventory. Only six respondents reported this type of flooding at their establishment.

If damage occurred to those vehicles, equipment, or inventory that were stored outside, but not to the buildings on the site, then they were included in the category of Storage Yard. Four interviewees told of the relief and disappointment they felt upon arriving at their work site. The relief stemmed from the knowledge that their building and its contents were spared from damage. The disappointment arose later, after they finished inspecting their offices and had begun to hope that they had escaped the flood totally unscathed. One reported that the damage to the items in the storage yard was not as frustrating to deal with as restoring order to the storage yard itself. His inventory included quite heavy metal products that could be cleaned and then later used or sold. However, the floodwaters caused them to float and shift about. Cleaning and returning them to their rightful places after the flood required a lot of physically exhausting labor.

Three interviewees reported that only a few inches of water made its way into their buildings. In one of these cases, this water was wind-blown rain that forced its way through the windows and doorjamb. Since there was no contamination from floodwaters;

only the carpet and the trim along the base of the walls required replacement. The drywall was not damaged at all. For the other two establishments, the minor flooding was also comparatively easily repaired. This proved to be not only a great morale booster, but also a time- and labor-saver as well. Once drywall absorbs floodwater, the drywall has to be replaced, as does the insulation behind the drywall. If the flooding is very extensive, then the wooden support beams inside the wall must be scrubbed to remove pathogenic molds, and allowed to dry out. Once the beams reach the mandated degree of “dryness” they must be bleached (in two separate sessions). This is done to prevent any toxic mold spores that may still remain in the pores of the wood from recolonizing the beams, new insulation, and new drywall after the structure is repaired.¹

Of the remaining interviewees, all ten had at least one foot or more of floodwaters in their buildings (Figure 23). The renovation of these facilities lasted days, weeks, or even months. This depended upon the severity of the damage, the availability of replacement material, and, in some cases, the availability of repair workers.

While the two topics just discussed in this chapter (Levels of Management, and Degree of Flooding) are relevant and valuable to this research, they do not really form the heart or the guts of the interviews. The heart of the interviews is presented in the following section (Employee Suffering). The guts of the interviews (Firm Difficulties) make up the last major section of this chapter.

Employee Suffering

Employee suffering was paramount in all discussions with interviewees. Most interviewees gave examples of losses suffered by some of their own employees. A few

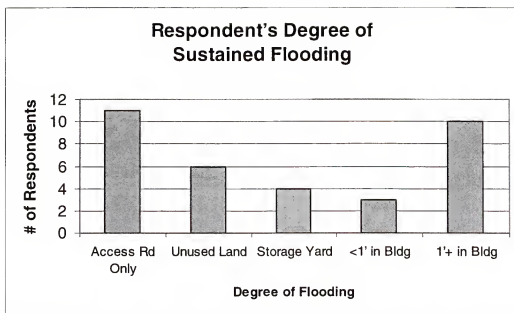


Figure 23—Respondent's Degree of Sustained Flooding

Note: No data available for 13 respondents

included discussions of losses suffered by neighbors and friends as well. There seemed to be a continuum that encompasses how these concerns were handled by employers. Small and large firms occupied the opposite ends of this spectrum. The results that follow tend to alternate between these two extremes. The conversations about employee suffering within the interviews fell loosely into two categories: Employee Losses and Recovery, and Lost Employees. Each is presented separately.

Employee Losses and Recovery

Many of the interviewees had employees who lost family members, homes, cars, and/or personal items to Floyd. Those owners or managers who directly worked with the affected employees as they struggled to cope with their personal losses in the weeks after Floyd were clearly more personally affected by the trauma suffered by their staff. Their entire demeanor changed to one of genuine empathy. In contrast, those senior managers who assigned an intermediary to intervene in aiding the workers tended to express

employee suffering in terms of setbacks or disadvantages to the firm. For instance, two separate owners of smaller medium-sized businesses (with fewer than 20 employees) pointed out that while only two or three of their employees lost everything, they represented a majority of the staff with a specific skill set. In one case, three of the firm's four delivery drivers lost everything. So even though the building, inventory, and other material aspects of the firm were unscathed, its ability to tend to the needs of customers was reduced by 75%. Due to an already tight labor market in 1999, replacing employees with temporary workers was even more difficult since many of these potential workers were themselves displaced. Small firms had the added difficulty of being unable to replace employees with "temps" lest the owner or manager create an environment of resentment or mistrust with his workforce.

Conversely, those senior managers who worked with affected employees focused their discussion on the employee's suffering. For instance, at one small establishment the office manager had to be rescued from the facility because she was not forewarned of the flooding. Later that evening the same employee had to be evacuated from her residence. The employer was sympathetic and supportive with this employee's efforts to cope with the flood's aftermath.

At almost all of the smallest firms the response strategy adopted was to close the business for 1-2 weeks. Employees that were still struggling with the aftermath were given extended time off. As these employees were eventually entitled to claim unemployment benefits², their salary was not continued during the period of closure or during their time off. Never once did any of these owners or managers blame their affected employees for losses the firm suffered because of the firm's closure or its

reduced manpower in the weeks after reopening. For example, one firm lost customers that were “high and dry” 70 miles away. One of the firm’s two drivers lost everything. This reduction in manpower, coupled with elaborately long delivery routes due to road closures, cost the firm some of its market share. But the owner had no regrets about giving time off to his employee. However, the owner’s disappointment regarding the clients’ shift to a competitor was apparent.

Large employers, in contrast, volunteered information on strategies developed to assist employees in their personal recovery efforts. These strategies covered four broad types of personal recovery:

- Housing issues
- Financial issues
- Emotional issues
- Replacement of clothing or household goods.

These are listed in the order that they were discussed during interviews. The list is not intended to be either an indication of the priority of these issues to employers, or the order in which employers addressed them.

Housing issues

Housing issues reflected the seriousness of the survival needs of the displaced. Those housed in public shelters often arrived unprepared. Some were away from home when the river rose, and unable to return for any “overnight” or personal belongings. Others arrived via helicopter or boat after being forced to leave personal belongings behind. Corbett (2001) reports that some displaced citizens even arrived at one shelter on jet skis. Many remained at the shelter for weeks—until they could return to their homes, or until they were forced to leave so that the shelter could return to its normal use.

Although most small firms lacked any resources with which to assist displaced employees (other than with unpaid time off), some of the medium-sized employers allowed one or two displaced single employees to temporarily reside in unused space at the firm's facility. In one instance, a medium-sized warehouse and transportation firm allowed an employee and his small family to "live" in the company's break room for a few weeks. A few of the largest employers actually provided hotel rooms for displaced staff and their families. These were national firms, or branches of multinational firms. One large employer even went so far as to provide interest-free loans for its displaced employees. While this particular employer had a few dozen employees' lives disrupted by Floyd, they represented only a very small proportion of its local staff. This brings up the strategies developed by firms to address the financial issues of the affected employees.

Financial issues

Only the largest employers (500+ employees) indicated that they developed strategies for providing financial assistance to affected employees. This does not include the numerous large and medium-sized employers that gave staff full pay for the time period in which the facility's operations were shut down. The larger employers continued to provide full pay to those employees who were unable to return to work for the first 2-3 weeks after the firm resumed operations. In addition, the largest employers offered bonuses to workers (up to \$200 per week) on top of the base salary, if they would return to work despite their serious personal problems. These interviewees stressed that they did not try to bully employees to report back to work. The staff was repeatedly reminded in

press announcements and at work that there would be no punitive repercussions if they needed time off to put their lives and homes back in order.

The other common form of financial assistance offered to affected staff was a monetary disbursement. Several medium-sized firms, and most large ones, reported setting up an internal disaster assistance fund for affected employees. In some cases unaffected employees also contributed to the fund. For a few establishments, employees at other company facilities (across the state and across the nation) likewise contributed to the employee relief fund. One Director of Human Resources was surprised and touched when a church group in West Virginia sent an unsolicited donation of several thousand dollars to their firm's employee relief fund. It turned out that a West Virginian relative of an unaffected employee heard about the company's efforts to help those staff suffering from the aftermath of Floyd. This relative persuaded the church congregation to organize a fundraiser to help.

For some of the large employers, these employee relief funds became problematic to administer. First, some scale of determining "who gets how much" needed to be developed. Should the employee whose rented mobile home containing all of his worldly possessions was destroyed receive as much as the employee who also lost everything—including the mobile home he was paying the mortgage on? Less problematic for fund distributors, but still of concern, was developing ratios for distributing funds to those that suffered less severely from the flood—for instance, determining how much to distribute to those who lost an insured automobile, but not their home and its contents.

At one firm, the relief money donated was so great, and the pool of recipients so relatively small, that the firm's management sent out a team to verify claims of damages

suffered. Those employees who indeed lost everything received over \$10,000 each from the firm's relief fund. (For some of the recipients, this represented more than half a year's salary.)

Another problem that arose for firms with large sums of corporate relief funds to disburse was avoiding potential labor-management repercussions once the experience of the disaster began to fade. Each of these firms indicated that they did not allow the immediate supervisor of disaster victims to sit on the committee that made the relief determinations. At one establishment, no manager was permitted to serve on the committee. They felt that having nonmanagement staff members fulfill this function would allow managers to maintain their "objectivity" at the following year's performance review of subordinates. Records of the sums disbursed, and to whom, were maintained by Personnel and not made part of the employees' files. In addition, those staff members who worked on these committees were required to sign a nondisclosure agreement so that fellow employees would not learn the details of who received what, and why. None of the firms that undertook this had any previous experience with aid collection, disbursement, or the related legal concerns. Nor had any of the managers at the impacted firms experience or expertise in assisting employees with their emotional recovery.

Emotional issues

The emotional scars for those whose lives were severely disrupted still linger. One interviewee reported that an employee who was evacuated from his home by boat is still haunted by the memories of the flood. For example, seeing a car on the road of the same make, model, and color of the own he owned reminds him of his evacuation, when the rescue boat floated past his submerged vehicle. Other employers described the

anxiety and panic attacks that displaced employees still experience during thunderstorms or heavy rain events. Those employees that lost family members are also coming to terms with their loss. At one establishment an office worker had been in the hospital undergoing necessary but not non-emergency surgery at the time the industrial district was being evacuated. By the time she came out from under the anesthesia, her home had been destroyed and her widowed mother had died in the flood. Because no other relatives were able to reach the hospital due to the flood, it was her boss who had to convey the news to her.

Some of the largest employers brought in counselors to assist employees. A multinational company even provided short-term, off-site counseling for the families of employee victims as well. The remainder of respondents did their best to be understanding. Several interviewees reported with embarrassment that some workers were grateful to be allowed to work; it gave them a brief reprieve from thinking about their problems. For many of these interviewees, it was this inability to assist more meaningfully in their employee's emotional recovery that seemed to haunt them most.

Replacement of material possessions

For some, leaving the shelter and going home—to assess the damage, to salvage whatever could be saved, to clean up and start over—was looked forward to. But the work was emotionally draining and physically exhausting. Finding irreplaceable mementos (e.g., photos, letters) hopelessly ruined was devastating. Scrubbing and bleaching away the fecal slime left behind by the floodwaters was grueling—especially if drywall and insulation had been contaminated. It then had to be cut away and hauled to the dump. Yet these victims were the lucky ones. At least they had a home to return to.

The rest shifted among family and friends, or took up residence in their car. Though it is obvious, the size of our residential space limits our material possessions. Starting over and trying to replace the clothing and household items destroyed by the flood became difficult for those with nowhere to store these replacement goods. Yet many of the medium and larger enterprises offered their employees donated items to replace those possessions destroyed in the flood.

Replacement of clothing and household goods seemed to be one of the most straightforward employee assistance tasks undertaken. These items were donated by fellow employees, clients, and vendors. In one instance, a furniture maker in the Piedmont donated numerous pieces of furniture. In most cases, however, the donated goods were new or used clothing or small household items.

Initially, the main concerns were finding space for the “company thrift shop,” providing assistance in transporting goods for those employees who no longer had cars, and assigning someone to oversee the “shop” itself. Oversight often involved verifying and documenting all donations. Since employees and their families were not charged for any items, proper money handling was not an issue. Eventually, roughly 4-6 weeks after the opening of the “shop,” the victims of disaster ceased to select items. At this point, the respective establishments needed to decide how best to dispose of this material. Each of the interviewees reported that the unselected goods were donated to various nongovernment relief organizations for distribution elsewhere in eastern North Carolina. The last of the categories of Employee Suffering covered during the interviews was that of “lost” or unaccounted for employees.

Lost employees

Several of the large employers, and a few of the medium and small employers, mentioned that there are employees who they still consider to be “missing.” Several of these interviewees assume that these unaccounted-for employees are now living in other cities (Raleigh and Wilmington were most often cited). The scenario most often presented is that the flood left these employees homeless. Lacking family close by (or having family who also lost everything), these employees moved in with relatives outside of the area.

In fact, none of these interviewees actually know what became of these employees. In the days after Floyd, employers were blitzing the local media in order to get the word out regarding when and where to report for work. As days passed, employers began trying to contact employees to learn whether or not they would eventually be able to return to work. Because so many people were left homeless (and phoneless), attempts were also made to reach next-of-kin. If these attempts were unsuccessful, then checks with local hospitals and shelters were necessary. For some small employers, the local grapevine was contacted to see if word could be had of the missing. Presumably, managers in large firms were not well enough acquainted with their employees to know at which part of the grapevine to place inquiries about their workers. Indeed, in order to reach employees, large firms more often reported contacting institutions, such as the media, shelters, churches, and other local groups. This more formalized approach at large firms may reflect attempts to reach efficiently larger numbers of displaced employees. Then again, it may indicate the limit of interaction among staff and managers at large facilities.

One Director of Human Resources summed up the frustration of not knowing about the well-being of lost employees. She pointed out that they had not been fired or terminated from their work. In fact, they could resume their job even today if they would only report back for work. She said, “But we don’t really know where they are. For all we know, they could have died during the flood.” But then again, maybe they really did move in with family in Raleigh. It is more hopeful to think so.

Firm Difficulties

Despite the emphasis during the interviews on the suffering and recovery of employees, there were discussions on the business decisions made during the aftermath, and their outcomes. These talks are grouped into seven broad categories. These categories reflect the broad extent of management leadership required in the wake of the flood. They are presented in the following order: Access to Site, Damage Control, Salvage Operations, Debris Removal, Facility Repair, Inventory Replacement, and Risk Reduction.

Access to site

This has been mentioned earlier in this report, yet not really described in any detail. As Gerard (2000) points out: what they do not tell you about hurricanes is the waiting—and the anxiety. For many owners and managers, anxiety about the flooding in the industrial district drove them to reach their site despite all obstacles. A few drove over 140 miles over countless back roads in order to find a path into the study area. At three establishments, at least one employee arrived at the site before the river crested. These employees then became trapped at the site. Two of these Robinson Crusoes were

maintenance men with some seniority at their respective employers. At the third establishment, it was the site's senior-most manager. This unlucky soul discovered too late that his workplace lacked a vending machine and he had neglected to bring any food with him.

Most of the others who struggled to reach their site did so in small flat-bottomed johnboats along inundated roads after the flood's crest. For example, at the intersection of northeast Greenville Boulevard (264A) and Industrial Road, there was over four feet of floodwaters on the roadways. In one case, an interviewee and one of his foremen hitched a ride in the back of a neighbor's truck. However, it was no ordinary truck. It was the very tall type used in quarries. The floodwaters reached less than halfway up the tires on this vehicle.

The floodwaters rose even higher on the western side of the study area, near where Greene Street crosses the Tar River. Two interviewees reported standing on the high, dry side of the Tar River peering through binoculars at their workplaces. What they observed, like the owners and managers accessing workplaces by whatever means necessary, set the stage for perhaps the most important business-related decision they made in the aftermath of Floyd.

This initial assessment allowed these senior managers or owners to decide how far they would go to keep the wheels of industry turning. In the case of at least one branch plant of a multinational, this choice was not for the local managers to make. Severe penalties are imposed on participants that fail to keep up in a high value, just-in-time production pipeline. Consequently, the extreme measures that this firm undertook (costing it over \$3 million dollars) were considered money well spent. This included

contracting a helicopter transport company based out of Norfolk, Virginia to run flights to a large dry area near the company's manufacturing plant. These flights would carry food, inputs, finished products, and employees. The staff that was stranded in the city of Greenville boarded helicopters at the hospital parking lot.³ Shuttle vans were provided to transport staff from the shelter to the hospital. For most of the plant workers, this was their first journey in an aircraft. Regrettably, their first flight included a bird's eye view of neighborhoods of friends or family (or even their own) submerged beneath fouled floodwaters.

An unfortunate drawback with this strategy of transporting employees was that except for military units, no organizations require the movement of hundreds of personnel in short time frames. These helicopters could only accommodate six passengers at a time. As a result, they were in perpetual flight—leading many other respondents to state that the area sounded “like a war zone.” Furthermore, it took so long to ferry by air the hundreds of workers needed for each shift from one side of the flooded river to the other, that the plant had to switch from (3) 8-hour shifts to (2) 12-hour shifts.⁴ To allow affected employees to still attend to personal survival issues, the firm persuaded the Red Cross, FEMA, and a counseling firm to set up temporary offices at the work site. The firm also provided free meals on and off-site. To alleviate employee anxiety about their loved ones, the firm also provided housing and meals to family members.

It is important to note that the firm's answer to “How hard will we strive?” was not necessarily a function of size. This previous firm's disaster response was dictated by the relatively high value of its product and the demanding relationship it had with its customers. For other manufacturers that also had demanding customers, but not a high-

value product line, the expense required for resuming operations before the floodwaters receded was unacceptably high. One manufacturing representative admitted that the end-products their plant produces simply do not have the profit margin necessary to justify elaborate measures for keeping the assembly line in operation. He reported that the plant “limped along” with an understaffed, easily “spooked” workforce for eight months. Because of increased competition in the market and higher than normal overtime costs, the facility was still feeling the effects of Floyd a year later.

There was another variation on the factors considered by management of a large employer before determining whether to or not to plunge back into operations while floodwaters lingered. The Human Resources Director at a very large employer with ample resources for recovery stated that they had the advantage of manufacturing an industrial product with little competition. The firm also controlled all of the distribution outlets for their product. When they realized that their facility was relatively unscathed, the decision was made to continue postponing the renewal of operations until the floodwaters fully receded. This “downtime” caused some inconvenience to buyers across the country until the backlog of orders was eliminated. On the other hand, it also allowed the management time to address a lot of the company’s response to its employee’s survival issues. For example, the flooding began on a payday Friday. As this firm was “local grown,” the managers adhered to the philosophy: if it ain’t broke, don’t fix it. As a result, the firm did not require all employees to receive their pay via an electronic transfer to their bank accounts. The Human Resources Department staff spent days visiting shelters and flooded homes trying to deliver paychecks.

In contrast to these strategies, some medium and large establishments were able to shift operations to “sister” establishments elsewhere in the state until the Greenville facility was once again operational. This entailed increasing the production levels at these other facilities until the flooded facility was restored to a full operational level. In some cases this took months. For those large establishments whose parent company had downsized “sister facilities” in years prior, this shifting of operations was not an option.

Examples of repercussions experienced by small firms provided earlier. It deserves to be restated, though, that small firms that waited until the worst was over often reported some loss of reputation, if not of market share. Many were resentful of the market’s perseverance in the pursuit of profit while the affected firms were still trying to recover from the flood. Conversely, those that adopted an “against all odds” philosophy saw their customer base expand even after Floyd became a memory. Their reputation of being able to pull through despite great adversity has proved to be a valuable asset.

A final consideration of firm size and disaster-response strategy deserves comment. There may be a threshold above which large firms may experience unexpected difficulties in responding to a disaster, despite the numerous resources at their employ. Those large establishments that out-source some of their low-skill, low-paying jobs, such as janitorial or food service positions, may find themselves encumbered by their subcontractor’s problems during the disaster’s aftermath. The subcontractor may have a significant proportion of its staff affected, whereas the large employer may have few or none affected. In this case, the problems that plague small firms can quickly become problems for the large firm. However, once employees begin returning to their work sites, damage control activities can begin.

Damage control

For the “early returners,” those owners and managers who returned to their workplace before the floodwaters receded, one of their objectives was damage control. All valuable files and equipment that could be saved or salvaged were shuttled back to dry land for transport to a temporary workplace. This initial response period also involved contacting all suppliers and asking them to postpone shipment (or to send it to their temporary facility, if appropriate). Similarly, customers (and corporate headquarters) also required contact. They needed some type of estimate for how long they would be without the products or services of the affected firm.

Some establishments had the wherewithal to develop flexible contingency or disaster plans that could change with the circumstances following the flood. For instance, the owner of a small firm arranged to “borrow” some workspace from a neighbor’s shop in a small, less patronized strip mall. Once the floodwaters subsided, stricter building standards were implemented for any new structures built within the floodplain. This extended by several months the time needed to rebuild the respondent’s facility.⁵ Unfortunately, the site being “borrowed” was zoned as a multi-commercial site. As a result of anonymous complaints, the displaced firm was forced to find a second temporary workspace.

Salvage operations

Because of the pollution problems associated with the flooding, few firms attempted to salvage goods contaminated by the flood. However, a brick wholesaler was especially pleased at being able to salvage several pallets of its bricks. Bricks are somewhat porous, and his had absorbed unknown amounts of the polluted floodwaters.

These bricks could not be reliably (and cheaply) decontaminated, so the entire inventory was slated for disposal. Luckily, they were able to salvage some of them for use in the construction of an underground sewer line, because using the bricks in this project posed no significant health threat to humans. The remainder of their inventory was destroyed. Many establishments with flooded outdoor storage yards lost most of their inventory as well. In addition, repair of vehicles and other equipment was not always possible.

For other employers, salvage operations were frustrated by the structural weakness of furniture constructed of particleboard and left to soak in standing water for days on end. Two interviewees reported the loss of most or all of their computer workstations, even though the entire machine was placed on top of the desk before evacuating the building. The desks had partially or completely collapsed from the weight of the material on them after the lower portions of the furniture became completely saturated. (None of these respondents had any inkling of how long floodwaters could remain standing in a given place.) In both of these cases the network server was on an elevated shelf, and above the maximum height of the floodwaters in the building. So the firm's computerized files were salvaged, even though the individual computers used to access the files were not.

Debris removal

A few establishments supplemented clean-up efforts by hiring debris removal teams. In many cases the debris originated in the structure or through the material associated with the establishment's operations. In a few cases it also included downed tree limbs. There were also a few reports where debris arrived at the establishment after

being carried along on the floodwaters. Periodically, the removal of debris required coordination with government agencies, as in the EPA example provided earlier.

Facility repair

For those establishments that were totally destroyed by the floodwaters, gutting and restoration (or outright replacement) of the facility could take months. Although there are several building contractors located within this study area, the demand for their services were so great that heavily damaged establishments had to periodically reassess the amount of work they would take on themselves in order to expedite their recovery. Those establishments with only minor damage almost invariably completed the work themselves. As these building repair tasks are usually not part of the skillset considered when hiring employees at non-construction-related enterprises, many of the employers acknowledged that their employees had to learn as they went. Consequently, the time they required in order to fulfill these tasks was longer than would be needed by a professional. The duration of the repair efforts was also prolonged due to interruptions during the repair work caused by the obligations of their “real jobs,” such as loading or unloading vehicles. A benefit of the do-it-yourself approach is the improvement to morale as staff begins to personally restore order to their workplace. Those establishments where the staff performed some or all of the clean-up and repair work had enormous pride in their accomplishments.⁶ In fact, several even had framed photographs in the lobby depicting the arrival of the first staff members on site either during or after the flood.

Inventory replacement

The two major problems seen in replacing damaged inventory are the availability of inputs and staff. In some cases, the inputs can be replaced relatively quickly once transportation routes are reopened. If the input is a raw material that has also been destroyed, such as a crop, then replacing the inventory requires purchasing the input until months in the future when a future crop is harvested. Labor shortages can constrain the replacement of inventory for both a short and long duration as well.

In the immediate period after the flood, there was a noticeable labor shortage at almost all employers. This was due in large part to the disruption of the employees' lives. In the first few weeks, these employees could not be supplemented with a temporary labor force due to the following reasons:

- Greenville, like the nation, had a somewhat tight labor market
- Many of the potential workers could not be reached—in many cases they had no phone, no residence, and no contactable kin
- The displaced needed time to address their survival needs, such as finding a residence.

As potential workers reached a point where they could take on extra hours, or an extra job, then firms began making genuine headway in reducing the backlog of orders and replacing the destroyed inventory.

At some manufacturers, once the assembly lines were operational again, the employees rallied in an effort to prevent falling even further behind on their orders. One Director of Human Resources reported that for the first two weeks of operation after the flood, the production level achieved *110% output*, even though only *80% of the staff* were working. Of course, this type of production level cannot be sustained over the long run, but the interviewee was clearly moved by the line workers determination to “beat Floyd,”

as he put it. The final category briefly describes what owners and managers did in response to their pre-Floyd risk reduction strategies.

Risk reduction

Two common methods for reducing risks to businesses from disasters are developing disaster plans and obtaining appropriate insurance. Numerous respondents did not have a formal disaster plan when Floyd hit. And many that did confessed that it focused more on human-induced emergencies, such as a fire at the facility. Consequently, even those with disaster plans discovered that they were inadequate. Several of the interviewees from larger firms indicated that their disaster plans are now much more comprehensive. Conversely, a storage and transportation operator admitted that his establishment had an “informal disaster plan” before Floyd hit. He said, “We knew what each client needed: which of their goods had to be delivered, and which could be put off,” without requiring extensive consultation with the client. As a result, his firm functioned adequately with only a skeletal crew. This success of this informal plan seemed to demonstrate to the general manager that a written disaster plan was unnecessary. Though the memories of Floyd are still vivid, other interviewees did not produce disaster plans after Floyd because of a lack of adequate time or junior management staff.

Almost all of the respondents reported that insurance issues were not of significant importance. Only two interviewees discussed insurance at all. One actually had flood coverage through the National Flood Insurance Program. Yet this coverage paid only 75% of his sustained, verifiable damages. The other interviewer spent almost an hour describing an 18-month battle to receive compensation from his insurance provider. He showed me the claim his firm submitted and, without exaggerating, it was

over six inches thick. He was informed that one of the reasons for the initial lack of progress on his claim was because it would be too time-consuming for a claims adjuster to evaluate it. The company's original ruling at the time of the interview was that the negligible damage from the storm event associated with Hurricane Floyd's crossing of the state would be covered. Any damage that resulted because of the flooding of the Tar River would not. After his protracted battle, the insurance company compromised: that damage that occurred before the Tar River in Greenville crested (at the height of the flood) would be covered under the policy. Any damage that occurred afterwards would not. It is not clear from the survey or the interviews how many firms lacked the resources to develop detailed insurance claims or to challenge unfavorable decisions in an attempt to increase their financial outcome. It is also unclear if such a strategy might not increase the establishment's insurance premiums to an untenable level.

This completes the qualitative analysis of the interviews. The following chapter provides information on the preliminary statistical analysis conducted on the quantitative variables.

Notes

¹ One interviewee sang the praises of paneling; unlike drywall, wood, or brick, well-made paneling is coated and therefore somewhat impervious to absorption of (polluted) water.

² It took several weeks before the state altered its standards for claiming unemployment benefits to accommodate for those rendered jobless by Floyd.

³ The finished product was flown to an airport in the Piedmont, where it could be transferred to trucks and then shipped to its destination.

⁴ There were some employees who expressed such a deep fear of flying that transporting them by helicopters was simply out of the question. The firm's need for assembly line staff was so great, that they arranged to shuttle them to work in a 50-passenger bus.

Unfortunately, in the first two weeks after the flood there were so many damaged roads and bridges, the only route available to such a large and heavy vehicle required *five hours of travel time in each direction*. Needless to say, the employees did not work consecutive days given the abnormally long commute and work hours.

⁵ A major difficulty for reconstruction efforts in the Coastal Plain of North Carolina was the high demand for clean fill, and the reduced number of sand mines able to fulfill these orders. Problems with the roads prevented the importing of clean fill from other areas for an extended period of time.

⁶ This is somewhat subjective, but in keeping with the study findings of Wilson *et al.* (2001). They report that those residents who continued to occupy their damaged homes during the its repair and renovation recovered emotionally much faster than those who were left without a home to repair.

CHAPTER 10

CORRELATION TEST OF POSTDISASTER BUSINESS RESPONSE VARIABLES

There are 76 variables within the data set used in this analysis. Many of them are the recoded variables discussed in Chapter 4. Because there is no statistical body of research into business response to disaster, and due to the limited number of responses in the data set, no formal test of the hypotheses in Chapter 4 was conducted. Instead, the analysis of these variables is limited to testing for independence between any given pair of variables. In addition, the analysis looked for trends between noncorrelated variables. This can provide valuable information to assist with the refinement of future research into this field. For instance, future surveys can be redesigned to eliminate obtaining data that is highly correlated with other information on the survey. SPSS, version 10, was used in this analysis because of its ease of use, and the variety of correlation tests offered. For this study, a Kendall's Tau-B association test was run on the variables. This is a common test for analyzing ranked or ordered categorical variables (Agresti 1996).

There is such a broad array of information covered in the survey instrument that an extensive discussion of all of the correlations within the data is beyond the scope of this research. However, this chapter presents seven broad categories in which the severity of business interruption correlates with other variables. For this discussion, the severity of business interruption is not limited to just the severity of interruption variable (SVINTPN). This variable is a measure of the overall interruption suffered by the establishment. In addition to this variable, all narrower severity of disruption variables

are also considered. Some examples include the severity of damage to the building (BLDGSV), and the severity of interruption of communications systems (COMMSV). A list of all of the variables used in this study is located in Appendix C. These correlations are presented within seven subsections to this chapter: Establishment Attributes, Commercial Factors, Dependence on Infrastructure, Level of Preparedness, Management Expertise, Human Factors, and Establishment's Response. The references to strong, moderate or mild correlations in this chapter follow the standards presented by Miles and Shevlin (2001). They cite Cohen's (1988) criteria that a large (strong) correlation is 0.5 or greater, a medium (moderate) correlation is 0.3-0.49, and a small (mild) correlation is 0.1-0.29.

Establishment Attributes

An easy way to describe business establishments is by their impersonal attributes. Some examples are their size, their industrial activity, and length of operations at their present location. For instance, a strong negative correlation exists between firm size and sites with an individual manager (OWNER) (Table 29). In other words, as a firm's size increases it is more likely to develop multiple levels of managers. As a firm size decreases it is more likely to employ only one manager or owner on site. The establishment's industry activity (INDUSTRY) provides an indicator of the impact the firm will suffer should its major clients' businesses be disrupted themselves (CLBRKYN). It also correlates with those few firms that reported being negatively affected by disrupted rail service (RAILSV). These correlations likely reflect the relationship of supporting industries to their major clients, and the need of some manufacturers for inputs, such as raw materials, that are supplied in bulk. Two such

manufacturing industries present in the sample are producers of chemical products and household cleaning supplies. The strongest correlation among establishment attributes is between the severity of building damage (BLDGSV) and the severity of damage to inventory (INVNTYSV). As the degree of building damage increases, there is an increase in the damage to inventory.

Table 29—Selected Establishment Attribute Correlations

Variable A	Variable B	Result	Percentile
#YRSGRVL	HURRICANES	0.291 *	
#YRSGRVL	MFGFLOOD	0.268 *	
FIRMSIZE	OWNER	-0.573 **	
FOREMEN	DIRECTRS	-0.518 **	
INDUSTRY	CLBRKYN	-0.319 *	
INDUSTRY	RAILYN	-0.489 *	
INVNTYSV	BLDGSV	0.555 **	

A third establishment trait that can explain some of the severity suffered is the length of time that the establishment has been operating at its site in the study area (#YRSGRVL). This variable has a mild, positive correlation with whether or not the greatest damage suffered by a manufacturer was due to flooding at its production site (MFGFLOOD). As the industrial district north of the Tar River was first being converted from agricultural land to mixed-use and industrial use, the land closest to the city, and therefore to the river, was developed first. This land is somewhat lower in elevation than the land currently being developed at the northernmost portion of the study area. In addition, those sites constructed before 1971 were not required to meet any minimum floor elevation standards. Neither the city nor the county adopted the National Floodplain Management Program guidelines until 1971. At that point building codes were strengthened, requiring new structures to be elevated in order to reduce the risk of being flooded. The older establishments tend to be closer to the river, and many of them had

some portion of their activities flooded. In addition to establishment traits, there are commercial factors that develop correlations with other variables.

Commercial Factors

An important commercial factor that turned up repeatedly in the correlation matrix was that of primary market areas. Both local markets (LOCALMKT) and national or international markets (NOREGNMKT) have moderate or strong correlations with multiple variables. In fact, there is a strong inverse relationship between these two market variables (Table 30). For example, those firms that reported primarily serving the local market (LOCALMKT) were more likely to be small (FIRMSIZE) and have only one manager on site (OWNER). This may reflect indirectly on the size of the firm, its role in supporting other local industries. Similarly, firms serving a market elsewhere in the state (OTRNCMKT) were less likely to employ upper managers (DIRECTRS) at their establishments.

Table 30—Selected Commercial Factor Correlations

Variable A	Variable B	Result	Percentile
ELECSV	NORGNMKT	-0.345 *	
LOCALMKT	DIRECTRS	-0.468 **	
LOCALMKT	FIRMSIZE	-0.311 *	
LOCALMKT	NORGNMKT	-0.536 *	
LOCALMKT	OWNER	0.348 *	
NORGNMKT	DIRECTRS	0.569 **	
NORGNMKT	OWNER	-0.413 **	
OTRNCMKT	DIRECTRS	-0.346 *	

At the other extreme of the primary market area, those firms that primarily serve a national or international market (NORGNMKT) were positively correlated (0.569) with firms having department or related senior managers (DIRECTRS). Those serving

national and international primary markets were negatively correlated (-0.413) with single-manager operations (OWNER). There is also a moderate inverse correlation (-0.345) between firms serving a national or international market (NORGNMKT) and the severity of disruption caused by a loss of electricity (ELECSV). This indicates those respondents reporting a high degree of disruption because of a power outage are less likely to serve a national or international market. It is possible that it is an indirect indicator of the human, financial, and material resources that firms large enough to serve national and international markets can draw on. Human resources include the many managers and their cumulative expertise to allow for scenario-building and disaster preparedness that includes purchasing electrical generators, fuel, and replacement parts well in advance. Financial resources refer to the money necessary to acquire, store, and maintain these and other emergency supplies. Material resources include not only the supplies themselves, but also the space to store them appropriately. Not all firms possess significant quantities of these three types of resources. The business factors presented here, however, neglect to consider the role of infrastructure on a firm's recovery from disaster.

Dependence on Infrastructure

Some examples already provided to illustrate the relationship between the loss of electrical service (ELECSV) and other variables. Another infrastructure element that was disruptive to all of the respondents was flooding and damage to the highway system. The severity of road disruption (ROADSV) has a positive correlation with disruption to the workforce—both management (MGMTSV) and staff members (STAFFSV) (Table 31). These moderate correlations indicate the importance of the roadways in order for people

to get back to work. Given that many of the workers in Greenville commute long distances, this vulnerability to road disruptions is understandable. The effect of impassable roads contributing to the severity of business disruption (SVRSPBRK) is also observed. Road disruption further influences the closure or permanent relocation of major clients (CLENDYN and CLPERMYN, respectively).

Table 31—Selected Infrastructure Correlations

Variable A	Variable B	-	Result	Percentile
ROADSV	CLENDYN			0.365 *
ROADSV	CLPERMYN			0.323 *
ROADSV	INVNTYSV			-0.353 *
ROADSV	MGMTSV			0.360 *
ROADSV	OTRNCMKT			-0.336 *
ROADSV	SAMEEMPL			-0.317 *
ROADSV	STAFFSV			0.389 *
ROADSV	SVRSPBRK			0.490 **

The mild inverse correlation between road damage and inventory damage may reflect the presence of those manufacturers that rely on bulk imports. There are a few rail spurs that lead to some manufacturing facilities and warehouse establishments. One interviewee reported that they receive inputs by rail roughly once a month. Since his plant and its warehouse were not flooded, and had received their usual supply of inputs shortly before Floyd, his firm did not notice any setbacks to the rail service.

Level of Preparedness

Two methods of evaluating a firm's level of preparedness are development of a disaster plan and obtaining adequate insurance coverage. This level of preparedness is couched in terms of "just-in-case" preparedness, as opposed to the "battening down the hatches" type of tasks completed in anticipation of an impending disaster. There were no significant correlations noted with whether or not an establishment had a disaster plan.

However, there are moderate positive correlations between adequate insurance preparation (OKINSUR) and firm's having a national or international market (NORGNMKT), in addition to a firm's refusal to consider relocating after Floyd (NOMVCONS) (Table 32). These may indicate the degree to which a business is capital-intensive, and therefore required by its lender to obtain insurance. Additionally, firms reporting adequate insurance coverage to deal with Floyd's aftermath may not have sustained enough damage to justify relocating. Or their operations may simply be too complex (e.g., manufacturing) to relocate easily.

Table 32—Selected Preparedness Correlations

Variable A	Variable B	Result	Percentile
OKINSUR	NOMVCONS	0.354 *	
OKINSUR	NORGNMKT	0.391 *	

Development of disaster plans and obtaining adequate insurance are tasks constrained by a manager's expertise.

Management Expertise

Although several examples of correlations have already appeared in this chapter, an important generalization deserves restating. A theme that consistently reappears throughout Chapters 8, 9, and 10, which describe the results of the data analysis, is the role that management expertise has in developing disaster response and recovery strategies. It reappears throughout the analysis that those establishments with multiple levels of higher management, such as Directors of Personnel, Sales, or Maintenance, possess the wherewithal to develop and implement complex responses to a disaster. Owner-operated establishments (or those with a single manager) report more vulnerability to the setbacks that a disaster brings. Several examples of the human factors

involved when management implements a disaster-response strategy follow in the next section.

Human Factors

There is a strong positive correlation between those firms that suffer setbacks because of the unavailability of their management (MGMTSV) and their staff (STAFFSV) (Table 33). In other words, those firms reporting their managers were unavailable as a result of the flood were more likely to report staff shortages, too. Likewise, there is a strong positive correlation between disruption of management and having a greater number of employees six months after the flood (MOREEMPL). But correlation is not an indication of causation (Kennedy 1998, Miles & Shevlin 2001). In almost all of the interviews it was evident that the management in these establishments do not live in or near the floodplain. A few were trapped at their unflooded home in the countryside; the vast majority was stranded in metropolitan Greenville. The disruption to them was not because of the flood's effect on their homes and private lives; it was an indicator of the difficulty they faced in doing their jobs from a nonwork location. A possible reason for the correlation between MGMTSV and MOREEMPL is that the disruption to the firm was so great that it prevented management from implementing decisions that could quickly restore operations. This setback to the establishment's operations therefore required additional manpower (as speed was apparently a necessity). Having a disruption to a firm that was so great it significantly disrupted management's activities would, in all likelihood, be even more disruptive to the lower-paid, lesser skilled staff (STAFFSV). Therefore, the positive correlation between MGMT and STAFFSV indicates that as the degree of business interruption due to the unavailability

of management increases, there is a concomitant increase in the degree of business interruption due to the unavailability of staff. One way that this manifests itself is in the management manpower needed to try to contact displaced employees. The employees required notification of new work routines and transportation routes to the facility; yet difficulties arose because of the destruction of homes and phones of employees and their next of kin.

Table 33—Selected Human Factors Correlations

Variable A	Variable B	Result	Percentile
MGMTSV	MOREEMPL	0.518 **	
MGMTSV	STAFFSV	0.675 **	
PRIEMPL	MOREEMPL	0.424 *	
PRIEMPL	NORGNMKT	0.343 *	

While MGMTSV and STAFFSV both represent the survey's attempts to evaluate the importance of the workforce in a business's disaster recovery, a similar variable was developed from the written responses on the survey in regards to the important issues that establishments faced in restoring normal operations. Getting employees back to work (PRIEMPL) moderately correlated with firms that had increased their employment levels 6 months after Floyd. The importance of the workforce correlated with firms serving a national or international market (NORGNMKT). These firms tend to be larger and serve a market unaffected by Floyd. Therefore, they were somewhat more likely to have hired more staff in the months after the flood. It is unclear from this analysis if the extra manpower was to overcome setbacks caused by the flood, or to accommodate increased demand within the marketplace. A final category for considering the correlations within the data set is the Establishment's Response.

Establishment's Response

Responses to the flooding fall within two general groups: Operational Responses and Locational Responses. Each is discussed separately.

Operational Responses

Three types of operational responses to disaster are addressed on the survey instrument: changing the scale of operations, changing the number of employees, and seeking financial assistance. Of course, no explanation is necessary for the positive correlation between those establishments that decreased their operational scale (DECROPN) and reduced employment levels six months after Floyd (FEWREMPL) (Table 34). Yet positive correlations among variables indicate that manpower is more likely to be greater six months after a disaster (MOREEMPL) if: the firm has a disaster plan (DISTRPLN), a national or international primary market (NORGNMKT), and severe disruptions at the time of the disaster that render management and staff unavailable to fulfill their duties (MGMTSV and STAFFSV, respectively).

Table 34—Selected Operational Response Correlations

Variable A	Variable B	Result	Percentile
DECROPN	FEWREMPL	0.447 **	
DECROPN	MOREEMPL	-0.396 *	
FEDASK	BLDGSV	0.470 **	
FEDASK	BRCHPLT	-0.404 *	
FEDASK	INDEPENDENT	0.468 **	
FEDASK	INVNTYSV	0.435 **	
FEDASK	LOCLECON	0.493 **	
MOREEMPL	DISTRPLN	0.410 *	
MOREEMPL	NORGNMKT	0.464 **	
MOREEMPL	MGMTSV	0.518 **	
MOREEMPL	STAFFSV	0.343 *	

Another type of operational response is aid-seeking by a firm. Among the businesses surveyed, the likelihood of a firm requesting financial aid from the federal government increased if it was an independent establishment (and therefore limited in its resources), if its inventory was severely damaged, or if it obtained its labor and inputs from the local economy (LOCLECON).

Locational Responses

A strong inverse relationship exists between the opposite locational options: refusing to consider relocation (NOMVCONS), and relocating temporarily (RELOCATE) (Table 35). Several examples were previously presented regarding these variables. However, an intriguing locational response variable was also included in the survey. Those respondents that considered moving their operations, but did not go through with it, were coded as HQCONSB. Those firms that considered moving temporarily but did not follow through are more likely to obtain their inputs and labor from the local economy (LOCLECON). They also were more likely to report decreasing the scale of their operations after the flood. This may not necessarily be a set of causal relationships. Additionally, the “considered but didn’t” group were somewhat more likely to have only a single-manager on site (OWNER), and to request financial assistance from the federal government.

Table 35—Selected Locational Response Correlations

HQCONSB	DECROPN	0.374 *
HQCONSB	FEDASK	0.547 **
HQCONSB	LOCLECON	0.460 **
HQCONSB	OWNER	0.332 *
RELOCATE	NOMVCONS	-0.841 **

While causality should be avoided in interpreting these correlations, the results seem to indicate some degree of complexity is involved in addressing a firm's impact from a disaster. Because this study is exploratory in nature, the results presented should be considered preliminary. Future research into postdisaster business behavior is needed. The following (final) chapter presents the conclusions of this research, and recommendations for future research.

CHAPTER 11

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

This research is an exploratory examination of the difficulties faced by firms in the wake of a natural disaster. The research drew upon a variety of theories as a result of the lack of previous research into disaster-response strategies by businesses. Although there is theoretical evidence that networks may play a role in a firm's survival from a disaster, the hypothesis was unable to be tested for this study. Greenville's role as an industrial node for a variety of manufacturers meant that participating establishments represented a diverse group of industry sectors. There were not enough members within any one industry sector to create horizontal networks within that sector.

On the other hand, just as a disastrous event has a temporal aspect, so too, does disaster recovery. The period immediately following a disaster finds firms, households, and individuals at their most vulnerable. For businesses, the availability of infrastructure is paramount to their survival during the first few weeks after a disaster. This is in keeping with studies of firm survival after devastating earthquakes and other natural disasters. However, this research revealed that disaster difficulties can last months. These longer duration difficulties include the salvage or replacement of materiel (inventory, raw materials, equipment, structures), and addressing employee hardships. Overcoming these hardships can take months. In addition, how a firm responded to the obstacles created by the disaster may reduce its long-term competitiveness. This temporal aspect of a firm's postdisaster behavior has not previously been examined.

Another element of importance to a firm's disaster response, but not addressed in other disaster research projects, is the need and method of addressing the hardships faced by employees in the wake of a disaster. Some employers developed complex strategies to assist their workers in overcoming the emotional, financial, and material losses caused by the flood. Because businesses are not typically viewed as an actor in the social aspect of a community's disaster recovery process, this aspect of postdisaster business behavior merits more study. All in all, this research has expanded the boundaries of understanding the disaster recovery process.

The conclusions, drawn from the results of this research, is presented in two major sections: Establishment Considerations, and Management Expertise. The final section of this chapter presents the recommendations for future research into the business response to disaster impacts.

Establishment Considerations

The study area in Greenville, North Carolina, includes a diverse group of participating firms. This area is an industrial district that houses several large manufacturing plants (PCDC 1999). However, there are also numerous supporting industries, such as trucking lines, industrial vehicle maintenance firms, and warehouses located in the study area as well. Furthermore, there are a number of less common establishments within the industrial district, such as the vertical integrator within the agricultural industry. There are also a several older, established subdivisions and supporting retailers in a portion of the industrial district, but which were excluded from the analysis.

The variation among business participants extended to establishment attributes, such as the number of employees, the firm's primary market area, and the degree of flooding sustained at the site. Such a mixture of attributes would prove beneficial to a detailed statistical analysis of the interactions among establishment factors, business network factors, and disaster factors. Unfortunately, the 41 usable surveys and the 28 interviews provided such diversity in their responses that many of the variables could not be used in their original form for a statistical analysis. These were instead recoded and then analyzed using the nonparametric test: Kendall's Tau-B.

The majority of participants in the study were manufacturers, wholesalers, or transportation and warehouse operators. These industries represent elements of the industrial economic multiplier effect on the economy of the Greenville Metropolitan Statistical Area. The employment levels at participating establishments ranged from fewer than ten employees to over 1000. In fact, roughly 34% of the respondents had fewer than 10 employees. The ratio of firm sizes present in this study differs considerably from those in other post-Hurricane Floyd studies conducted in North Carolina (FEMA 2000b, Wilson *et al.* 1999). There were more large and medium firms and fewer small firms in this research. This discrepancy is due to the intentional elimination of those firms that serve individuals and households from participating in this research.

The primary market area of respondents exhibited some industry-specific variation. For instance, wholesalers seemed somewhat limited to an in-state primary market. Manufacturers, on the other hand, crossed a broad range of primary market areas, from local to national. This reflects, in part, the function and operational type of manufacturing establishment. For instance, a manufacturer that produced an assembled

input for a nearby manufacturer has a local market. In contrast, a branch plant of a national firm has a far larger primary market—either regional or national.

The relationship between the age of an establishment and the expansion potential of the firm's site may influence a firm's postdisaster location decision. Newer establishments, located within the study area for a decade or less, were more likely to report that their site has poor or unsatisfactory expansion potential. Should the facility be destroyed during a disaster, then the firm may use that opportunity to relocate their operations away from the disaster zone. Of course, site ownership may act to discourage relocation of a facility after a disaster. Among respondents, there was a 23:17 split in favor of ownership, with one respondent not indicating whether the site was owned or leased. However, because only a limited number of respondents relocated temporarily, ownership may not have played such a significant role in relocation decisions in Greenville.

Disaster preparedness, on the other hand, may reduce the damage or business interruption a firm can suffer due to a natural disaster. For this study, the measurement of disaster preparedness was limited to the adequacy of insurance coverage carried by a responding firm, and the development of a disaster plan. Over 60% of the respondents reported having adequate insurance coverage to address the damage sustained by Floyd. However, many of these establishments suffered little or no structural damage. Likewise, some firms that experienced little or no significant damage also reported that their disaster plan was adequate. For those establishments that suffered major physical damage to their buildings or materiel, or whose employees' home lives were completely disrupted, the impact caused by Floyd could not be quickly remedied.

Severe structural damage because of the flooding caused several of the 13 respondents to relocate at least temporarily. Most of these relocations lasted until the floodwater receded (up to 14 days in some areas). Four required weeks or months to repair or rebuild their facility after the floods. Yet, even those firms that did not relocate saw their activities severely disrupted by the flood. For instance, immediate (or short-term) disruption issues centered around infrastructure and labor availability problems. Flooded roads, loss of electricity and phone service were all of short duration. Yet each of them had serious ramifications for affected businesses.

Impassable roads prevented managers and staff alike from reaching the workplace. It also prevented the arrival of inputs and shipment of products. Once the flood receded, damage to road surfaces, roadbeds, and bridges resulted in long, time-consuming detours for weeks afterwards. This roadway disruption affected not only the respondents and their employees, but also their clients in Greenville and elsewhere in eastern North Carolina. Another infrastructure disruption that caused problems across the Coastal Plain was the loss of electrical service. Greenville was fortunate in that their electrical outage lasted less than 2 days. As a result, within the study area the loss of regular phone service was more disruptive to businesses than the loss of electricity. (This was not true for businesses elsewhere in the Coastal Plain.) Although cell phone service was available during the flood, few businesses and employees had a cell phone. Consequently, trying to contact staff, clients, suppliers, corporate headquarters, the press, and others was problematic for many establishments.

Getting employees back to work was also a major factor in business disruption from Floyd. Three types of problems arose in trying to restore the workforce to pre-Floyd

levels: employees needing time off to address survival and mental health issues, inability to contact staff, and limitations to the availability and hiring of temporary workers. The survival issues of employees focused on obtaining housing, food, water, clothing, and transportation. While many homeless victims moved into the homes of family or friends, this was a temporary solution at best. In cases where the kinfolk or neighbors were also rendered homeless, the displaced could search farther afield for housing, go to a shelter, live in their car or, in some cases, temporarily lives in space provided by their employer. Additionally, both the disruption of employees' home life and of phone service made it extremely difficult to for managers to contact their staff. A few firms reported that even now they do not know what became of some of those employees who could not be found after Hurricane Floyd. In the aftermath of the flood, the employers were likewise limited in their ability to hire temporary workers to help reduce the backlog of orders. Fear of replacement by outsiders was but one factor limiting the immediate hiring of temporary workers. Other factors were an already tight labor market before the storm, and difficulty in getting the word out about employment opportunities. A final factor was that much of the potential temporary workforce was left homeless too.

Business disruption, though, is not solely comprised of short-duration problems. Destroyed materiel, such as inventory, inputs, and equipment can take months to replace. Just as with building damage, these physical losses represent significant longer-term setbacks to the firm. These setbacks included the loss of the item itself, the time and manpower diverted to repair or replace it, and the revenue lost because the final product was never completed. Therefore, it never made it to the market.

Long-term disruption due to employee survival issues was indicated as well. Just as a firm can take months to repair its facility, the same is equally true for employees trying to restore their home lives. For those renters whose landlords opted not to rebuild, the competition for limited available housing stretched thin their meager resources. Emotional trauma from the flood also requires months or even years to overcome. For many employers, providing opportunities for their staff to address ongoing survival issues contributed to the long-term nature of their staff-related difficulties for the firm.

Some response options open to a firm in the wake of a disaster include changing the scale of operations or changing the level of employment at the facility. While almost one quarter of respondents (six of them) decreased their scale of operations, more than half remained the same. Interestingly, six establishments opted to increase employment. Another option for responding to a disaster is for a firm to request a loan from a commercial lender, or financial assistance from government. Those firms that reported losing customers were more likely to report requiring financial help. Only six respondents reported requesting financial help from the federal government, and five received it. Two of these recipients also requested and received state aid.

For the respondents, however, financial concerns were seldom reported as important in restoring the facility to normal operations. The three factors most often cited were restoring road and highway travel, getting employees back to work, and dealing with the variety of “management issues” that Floyd created. These management issues include safety concerns, such as dealing with residue from polluted floodwaters onsite, downed power lines, worker injuries, and wildlife seeking sanctuary in the workplace. It

also includes conducting damage assessments, reaching flooded customers, and prioritizing recovery tasks. This, of course, brings up the issue of management expertise.

Management Expertise

This research demonstrates that there is a relationship between the levels of management present at an establishment and the complexity of its disaster response. This is in large part a function of larger firms having access to more resources upon which to draw, and the management manpower to utilize them effectively. These resources are not only financial; the larger number of managers present allows them the opportunity to task some of them with the oversight of specific disaster recovery activities, while the remainder focus on traditional facility operations. These disaster recovery activities included conducting more detailed damage assessment and salvage operations, and establishing employee recovery centers staffed with counselors, Red Cross representatives, and/or FEMA representatives. A manager may also create and coordinate an employee disaster relief fund. There does seem to be a point where size seems to lose some of its “resource advantage,” though. If an establishment is so large that it has begun to hire subcontractors to perform necessary tasks onsite (such as custodial duties), then the obstacles encountered by the subcontractor become obstacles for the large firm in its attempts to overcome the effects of the disaster.

There are other issues faced by those smaller firms that lack the extra managers to allow for reassignment to disaster recovery duties. Those firms with only one senior decision-maker most often chose to postpone reopening the business after the flood to allow employees more time to address their own survival issues. They were also more likely to restrict their employee assistance efforts to allowing a displaced employee (and

his family) to reside at the facility for a few weeks, or to provide them with as much unpaid time off as they required. This was not done in a “Scrooge-like” effort to be ungenerous. Rather, these were the few options that the smaller firms could accommodate without jeopardizing the survival of the firm. Those smaller firms with only one manager or owner on site more often reported being closed due to the floods, losing customers, and placing a high priority on getting employees back to work. However, care must be taken not to impart causality to any of these interrelated variables.

Figure 24 illustrates the varying degrees of complexity of disaster responses performed by the establishments interviewed for this study. Since a comparison of the levels of management at a firm and the complexity of its response strategy were not part of the original objective of this study, there may be some lack of precision in the details. However, it is the trends that are significant. For example, most small firms have only one manager (Boss), and tended to have very simple response strategies (close shop, unpaid leave). There were, however, a few that attempted more complex activities, such as providing limited help to employees or temporarily relocating. Firms with a senior manager and subordinate supervisors having limited authority (Boss and Foremen) also responded to the disaster with plans of low complexity.

There is a noticeable, but predictable gap between small and medium-sized firms and those large firms having multiple managers (Multiple Mgrs). These large establishments have more resources to draw upon: more knowledge and expertise among their management for developing and implementing disaster plans, more financial resources to fund recovery efforts, and more material goods available for use in the recovery process. Material goods includes inventory and raw materials stored elsewhere

in the corporate hierarchy, workspace for establishing assistance or distribution centers onsite, and a network of unaffected clients and employees willing to donate money or replacement items for the benefit of displaced staff members. These donations help affected employees overcome some of the hardships caused by the flood. Yet each of these activities increased the complexity of response for a firm suffering its own setbacks. The overall trend seen is towards increasingly complex responses at establishments with each type of management level, with the most complex responses occurring at the largest firms. However, there is a point where size is not as beneficial in developing complex disaster-response strategies. The response at one of the largest firms in the industrial district was less complex than that of firms half its size, despite the significant number of managers at the facility. This firm had subcontractors onsite that handled the low-wage, low-skill jobs, such as custodial work and food preparation. The flood displaced many of these low-wage workers. Because they were not employees of the large firm, the large firm's response to their difficulties was limited.

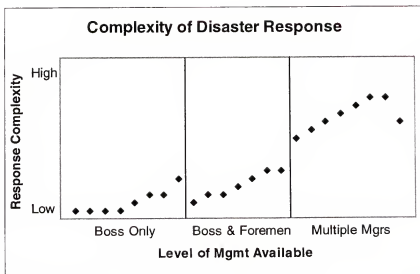


Figure 24—Complexity of Disaster-Response Strategy

The figure was generated to illustrate the variation in complexity observed during the interviews for this study. Facilities with Managers and Foremen were more likely to be unavailable for interviews, and are not as proportionately well represented in the interview data. It is not clear why this difficulty arose with firms of this type more so than any other, but it may reflect the “growing pains” of these medium-sized firms. In fact, it was this difficulty in obtaining face-to-face contact with these Boss and Foremen establishments that led to the evaluation of levels of management as being of significance in the firm’s disaster-response process. The Y axis was generated by counting up the number of disaster-response activities each interviewed firm performed. Although there were 16 tasks reported altogether, no one establishment performed all 16. This total may not be true for all types of disasters, or in disasters where the structural damage is great, such as after a tornado outbreak or following the World Trade Center attack. Additionally, the interviews were semi-structured, with the intent of uncovering trends in a firm’s disaster response. As a result, there are limitations to the interpretation of this figure.

Another facet of management expertise that was emphasized by the disaster was an establishment’s ability to prioritize and follow through with the following tasks during its disaster response:

- access the site
- conduct damage control
- conduct salvage operations
- remove debris and restore order
- repair the facility and repair or replace its contents
- address manpower needs
- reduce risk of a repeat disaster.

Possessing a disaster plan was no guarantee that a firm was prepared to identify and complete these tasks. This is because many of the disaster plans did not address a flood event. In fact, none of the respondents had ever experienced a flood before. When the Tar River began rising, no one in the area knew how many days would pass before the floodwaters receded.

Those that chose to grab the bull by the horns and gain access to the site seemed to suffer fewer setbacks on the whole than those that waited. It is likely that their speed in initiating their disaster response reduced the opportunity for competitors to take advantage of the circumstances. However, a few of these “gung-ho” establishments actually reached their site before the river crested, and ended up trapped at work for a few days. In general, though, those that were quick to initiate their postdisaster response were more likely to develop adaptive operational strategies in response to the flood. Because of the exploratory nature of this research, these findings bring up a number of potential research topics that would help to develop our understanding of how businesses respond to a disaster.

Recommendations for Future Research

Clearly, continuing this research in other cities with affected industrial areas would allow for additional responses to be collected to the variables used in this research. A larger number of respondents would permit analysis of a variety of business elements, and their role in postdisaster business response. The following list includes examples of analysis that would benefit from larger response rates:

- A comparison of response strategies by business within and across industry sectors
- An analysis of the degree of disruption caused by various business elements, such as management and staff availability, or transportation system disruptions

- The extent to which financial aid seeking after a disaster is beneficial or detrimental
- An examination into whether the degree of disruption incurred by network members influences the degree of cooperative response strategies among them

However, there are other research topics that would also prove valuable, such as further investigating how businesses respond to a disaster. These include the manner and extent to which planning guidelines influence a disaster's outcome, and spatial investigations of the variation of impacts within a disaster zone.

How Businesses Respond to a Disaster

The following list presents two possible areas of future research into how businesses respond to a disaster:

- Further investigation into the role of management expertise and management resources in developing disaster-response strategies
- Whether firms located in a region dense with a specific industry type (such as Manhattan), develop similar response pattern to a disaster.

For example, would firms be less likely to relocate in order to maintain links to an area of geographical importance to their business? A second research possibility (also in a setting like Manhattan) is to examine whether business networks are more influential in developing a firm's disaster response in a location where a single industry has many firms present. On the other hand, research into the effect of government planning guidelines on disaster outcomes of firms would also prove insightful.

Extent of Government Planning Guidelines

An examination of the role of planning guidelines can provide valuable information to governments struggling with the aftermath of a disaster. This is frequently a time when new, short-term policies are proposed, established guidelines are questioned, and variances to existing policies are hotly debated. Firms whose facilities

are completely destroyed are in need of an immediate replacement, simply because the competitive marketplace will take advantage of this opportunity to obtain customers at the impacted firm's expense. If appropriately zoned space is unavailable, the community risks having the employer relocate elsewhere. Yet rezoning can create a host of other regulatory problems. The primary problem is setting a potentially undesirable precedent. Strengthening of building and environmental standards in the wake of a disaster increases the recovery costs for affected businesses. In some cases, more stringent standards can prohibit the renewal of a firm's operation—especially if the firm engages in noxious activities. For example, Stephenson (2000) recommends prohibiting the repair or reconstruction of hog waste lagoons. Such a policy would result in the outright elimination of large-scale hog production activities in much of eastern North Carolina.

In addition, after a disaster occurs local governments frequently toughen their regulatory standards. This is usually criticized by the impacted business community. Yet there is no research to indicate if more stringent building and zoning requirements encourage out-migration of firms (or, if so, what type of firms). A final research possibility has a longer timeframe, and focuses on the regulatory environment's ability to foster or hinder a reduction of risk to natural hazards. Government guidelines can restrict the development of residential or commercial facilities that expose themselves to a natural hazard. Changes to the guidelines (or their enforcement) may result in a built environment that increases, rather than decreases, the risk exposure of an establishment's facility. For example, if a manufacturing plant is built in proximity to a river's floodplain, and over the course of twenty years construction upstream leads to substantially higher streamflow rates during storms, then the facility is in greater danger

of being flooded than it was when it was built. This increased risk can be seen by changes to the guidelines that require higher minimum floor elevations of structures over the intervening decades.

Spatial Investigation of a Disaster Impact Zone

A final consideration for future research involves investigation the spatial patterns found in disaster impact zones. The maps of disaster impact areas are somewhat generalized, and paint broad strokes of devastation when there may be pockets of unharmed structures. For instance, the map produced by Pitt County planners of flooded areas in the county indicate that essentially all of the study area was flooded (PCPB 2000). Yet this study's participants indicated that there was a range of flood damage experienced that extended from none at all to extreme. The variations in the study area's topography, along with the man-made changes to the landscape (such as drainage canals and retention ponds), influenced the outcome of the flood. In fact, it was not uncommon to learn that of two facilities situated less than 50 feet (15m) apart, one was flooded and one was not. And in at least two cases, this was attributed to the man-made flood containment structure built near the facility. A better understanding of the spatial attributes of damage patterns may, in turn, lead to spatial studies of reconstruction activities. For instance, are infrastructure services (such as electricity) restored to certain affected regions first, despite obstacles that would suggest that it would be more efficient to restore services to a different region first? One possibility for studying this would be to examine whether or not electrical services restored to industrial or higher-income areas before they are restored to lower-income areas.

There is a lot of room for the application of research methods developed by economic geographers to the events and processes of postdisaster circumstances. Such study would greatly improve our understanding of the dynamic processes that occur after a disaster strikes.

APPENDIX A SAFFIR-SIMPSON SCALE

Category 1 Hurricane

Winds: 74-95 mph (64-82 kt or 119-153 km/hr)

Storm Surge: approximately 4-5 ft above normal

Damage: no real damage to buildings, except for unanchored mobile homes; minor damage to piers, poorly constructed signs, and plants (shrubbery, trees);

Flooding: some coastal roads

Category 2 Hurricane

Winds: 96-110 mph (83-95 kt or 154-177 km/hr)

Storm Surge: approximately 6-8 ft above normal

Damage: buildings suffer damage to roofing materials, doors, and windows; considerable damage to mobile homes, piers, and poorly constructed signs; shrubbery defoliated and trees blown down; small craft in unprotected anchorages break moorings

Flooding: coastal roads flood 2-4 hours before arrival of hurricane's center

Category 3 Hurricane

Winds: 111-130 mph (96-113 kt or 178-209 km/hr)

Storm Surge: approximately 9-12 ft above normal

Damage: some structural damage to small residences and utility buildings with a minor amount of curtainwall failures; mobile homes and poorly constructed signs destroyed; trees defoliated and large trees blown down; smaller structures near the coast destroyed by flooding; larger structures near the coast battered by floating debris

Flooding: low-lying escape routes impassable (flooded) 3-5 hours before arrival of hurricane's center; terrain continuously lower than 5' below mean sea level may be flooded up to 8 miles (13km) or more inland

Evacuation: evacuation of low-lying residences within several blocks of the shoreline may be required

Category 4 Hurricane

Winds: 131-155 mph (114-135 kt or 210 -249 km/hr)

Storm Surge: approximately 13-18 ft above normal

Damage: small residences suffer more extensive curtain wall failures with some complete roof structure failures; extensive damage to doors and windows; major damage to lower floors of structures near the shore

Flooding: low-lying escape routes impassable (flooded) 3-5 hours before arrival of hurricane's center; terrain lower than 10' below mean sea level may be flooded up to 6 miles (10 km) or more inland

Evacuation: massive evacuation of residential areas up to 6 miles (10 km) inland may be required

Category 5 Hurricane

Winds: 155+ mph (135+ kt or 249+ km/hr)

Storm Surge: approximately 18 ft above normal

Damage: complete roof failure on many residences and industrial buildings, with severe or extensive window and door damage; some complete building failures (including utility buildings that may be blown over or away); complete destruction of all mobile homes; major damage to lower floors of all structures located less than 15' above sea level and within 500 yards of the shoreline; all shrubs, trees, and signs blown down;

Flooding: low-lying escape routes impassable (flooded) 3-5 hours before arrival of hurricane's center; terrain lower than 10' below mean sea level may be flooded up to 6 miles (10 km) or more inland

Evacuation: massive evacuation of residential areas within 5-10 miles (8-16 km) of the shoreline may be required

(Source: National Hurricane Center, www.nhc.noaa.gov/aboutsshs.htm)

APPENDIX B SURVEY QUESTIONNAIRE

Survey: Business Response to Hurricane Floyd in Greenville, NC

The purpose of this survey is to learn how a firm responds geographically to a natural disaster. The main focus of this survey is on whether or not firms consider relocating their operations (temporarily or permanently) after a disaster occurs. The survey also looks at whether or not the firm did relocate, and what criteria were most important to the firm in making this decision. The survey is broken down into 4 sections in order to elicit general information that may support or reject the economic and disaster recovery theories being tested through this research.

Part I. Disaster Factors

The following questions will ask about your firm's experience(s) with natural disasters in general, and with Hurricane Floyd in particular.

1. Please write in the blank the number of times (if any) that your firm has experienced each of the natural hazard events listed below in the five years prior to Hurricane Floyd, 1995-1999 (do not include Floyd).

Floods	_____
Hurricanes (not Floyd)	_____
High (Severe) Wind Events	_____
Other Climatologic Events	_____
2. Did your firm have a Disaster Plan prior to Hurricane Floyd? Yes _____ No _____
If yes, was it adequate to deal with Floyd's consequences? Yes _____ No _____
3. Did your establishment have adequate insurance coverage for damage caused by Floyd?
Yes _____ No _____
4. Did your establishment have business interruption insurance?
Yes _____ No _____
5. Please circle the number that matches the extent of business interruption Floyd caused your firm.

1 = none	3 = moderate	5 = extreme
2 = minor	4 = severe	
6. Please enter the approximate distance in miles to the nearest natural hazard (i.e., river, sound, etc.).

Headquarters	_____
Logistics	_____
Manufacturing	_____
R&D	_____
Other	_____

7. Using the table below, please mark those attributes of Hurricane Floyd that were the source of the **most damage** to your activities.

Firm activity	from Flooding	from High Winds	from Building Quality	from Other Causes
Headquarters				
Logistics				
Manufacturing				
R&D				
Other				

8. Please check the appropriate boxes below if your firm considered (or followed through) with **relocating** any of its activities.

Firm activity	Did not consider relocation	Considered relocating, but didn't	Temporarily relocated (# days)	Permanently relocated
Headquarters				
Logistics				
Manufacturing				
R&D				
Other				

9. Using the table below, please indicate **how far away** any of your firm's operations **relocated** after Floyd.

Firm Activity	Did Not Consider Moving	No Suitable Site Available	Moved Else- where On Site	Moved Off Site Same Gov't	Moved Off Site New Gov't
Headquarters					
Logistics					
Manufacturing					
R&D					
Other					

10. What factors discouraged your firm from relocating your operations?

None _____ Sunk Costs _____
 Business Ties _____ Social Ties _____
 Local Market _____ Local Materials _____
 Labor Limitations Elsewhere _____
 Lack of Suitable Location _____
 Other _____

11. The following table asks two questions: what was the degree of business interruption your firm suffered due to Hurricane Floyd, and how many weeks did it last? Please enter the degree of interruption using this scale: (1=none, 2=minor, 3=moderate, 4=severe, 5=extreme), and please write in the number of days that this business interruption lasted for each item listed.

Degree and Length of Business Interruption

(1 = none, 2 = minor, 3 = moderate, 4 = severe, 5 = extreme)

Affected Business Elements	Degree of Business Interruption	Length of Business Interruption (# days)
Building Damage		
Equipment Damage		
Inventory Damage		
Availability of Raw Materials		
Availability of Assembled Inputs		
Availability of Management		
Availability of Staff		
Loss of Communications		
Loss of Electricity		
Availability of Firm's Financial Provider		
Disruption of Roadways		
Disruption of Railways		
Disruption of Marine Shipping		
Disruption of Air Transportation		

Please continue on the other side



Part II. Establishment Factors

The objective of this section is to learn what business factors influenced your firm's locational response to Hurricane Floyd.

12. What type of products does your firm manufacture (or what is your SIC code)?

13. How many employees are at this establishment? _____

14. Six months after Floyd, how many employees did your establishment have?

Fewer _____ Same # _____ More _____

15. Please indicate your firm's *Operation Type*:

Independent _____ Franchise _____

Branch Plant _____ Subsidiary _____

Other _____

16. Please indicate your firm's
- site location traits*
- :

Firm Owns the site _____

Firm Leases the site _____

17. Number of years your firm has occupied the site _____

18. Is the site's
- potential for expansion*
- :

Excellent _____

Good _____

Adequate _____

Poor _____

Unsatisfactory _____

19. If your firm's scale of operations changed as a result of Floyd, did they increase _____ or decrease _____?

20. Does your firm use computer technology in its manufacturing process? Yes _____ No _____

21. Is your primary market:

Local _____ Elsewhere in NC _____

SE US _____ Nat'l _____ Int'l _____

Part III. Network Factors

These questions are intended to elicit whether or not a firm's membership in a network influences its location decisions after a disaster.

22. Did your firm's decision for or against relocation influence the location decisions of any of the firms you often transact business with? Yes _____ No _____

If yes, approximately how many firms? _____

23. (This is the inverse of question 22, above.) Did any of the firms with whom you often transact business make a decision to relocate or to remain in the disaster zone that influenced your firm's decision?

Yes _____ No _____

If yes, approximately how many firms? _____

Network Traits

24. Generally speaking, to what extent was your firm
- unable to interact with Major Clients?**

(1 = none, 2 = minor, 3 = moderate, 4 = severe, 5 = extreme)

Because of Major Client's Problems

Interruption of Their Business Activity

1 2 3 4 5

Temporary Relocation of Their Business

1 2 3 4 5

Permanent Relocation of Their Business

1 2 3 4 5

Termination (Closure) of Their Business

1 2 3 4 5

Other _____

1 2 3 4 5

Because of Your Firm's Problems

Interruption of Your Business Activity

1 2 3 4 5

Temporary Relocation of Your Business

1 2 3 4 5

Permanent Relocation of Your Business

1 2 3 4 5

Other _____

1 2 3 4 5

25. How many business clients did your firm **lose** because of Hurricane Floyd? _____
26. How many business clients did your firm **gain** as a result of Hurricane Floyd? _____

Part IV. Government Assistance

The purpose of this section is to learn the extent to which government assistance influences business location decisions after a natural disaster.

27. Was your firm financially able to absorb the costs associated with Floyd's impact without obtaining *non-government* loans or grants? Yes _____ No _____
28. If your firm requested **financial or technical** assistance from any agency, please check the appropriate boxes below.

Agency	Financial Aid		Technical Aid	
	Requested	Received	Requested	Received
Non-Profit				
Business Assoc.				
Local Gov't				
State Gov't				
Federal Gov't				
Int'l Gov't				

29. If your firm received financial assistance due to Hurricane Floyd:
- Did it improve your firm's overall situation?
Yes _____ No _____
 - Did government assistance influence your firm's decision regarding relocating from your pre-Floyd location?
Yes _____ No _____

LAST QUESTION

What was (were) the most important thing(s) in getting your firm back to full (100%) operation after Hurricane Floyd?

Thank you for completing this survey. Your assistance with this research is deeply appreciated. If you'd like to receive a copy of the summary report, please let me know. If you have any questions or comments about the survey or the research, please feel free to contact me. I would appreciate hearing from you.

Sincerely,
 Ann Angelheart 352-380-9336 aglheart@geog.ufl.edu
 Dept. of Geography, University of Florida
 P.O. Box 117315, Gainesville, FL 32611-7315

APPENDIX C RESEARCH VARIABLES

Variables are listed in their order of appearance in the survey instrument, by survey section. Variables listed in italics are those recoded from other variables. Recoded variables are in the same section as the original variables used in the recoding process. Variables followed by 'n' had fewer than 5 responses. Variables followed by an asterisk (*) were not used due to problems with the survey question. Variables followed by an exclamation point (!) had zero responses.

Table 36—Research Variables

Variable Abbreviation	Variable
Disaster Variables	
FLOODS 'n'	Number of floods experienced
Hurricanes	Number of hurricanes experienced
High Wind 'n'	Number of high wind events (e.g. tornadoes) experienced
Otr Climate 'n'	Number of other climate events (hail storms, snow storms) experienced
DistrPlan	Possession of a disaster plan
OKDISPLN	Adequacy of disaster plan
OKINSUR	Adequacy of insurance
BUSBKINS	Possession of Business interruption insurance
EXTBUSBK	The extent of the Business interruption (1-5 scale)
DIST2HAZ *	Distance to the nearest natural hazard (e.g., river) in miles
SEVINTPN	Overall degree of severity of Business interruption (severe/extreme or not)
Source of Damage	
HQFLOODS	Damage to HQ was due to flood
HQWINDS 'n'	Damage to HQ was due to high winds
HQBLDGQL !	Damage to HQ was due to building quality
HQOTHER 'n'	Damage to HQ was due to other factors
LGFLOODS	Damage to logistics operations was due to flood
LGWINDS 'n'	Damage to logistics operations was due to high winds
LGBLDGQL 'n'	Damage to logistics operations was due to building quality
LGOTHER 'n'	Damage to logistics operations was due to other factors
MFGFLOOD	Damage to manufacturing operations was due to flood
MFGWINDS !	Damage to manufacturing operations was due to high winds
MFGBLDQL !	Damage to manufacturing operations was due to building quality
MFGOTHER 'n'	Damage to manufacturing operations was due to other factors
RDFLOODS 'n'	Damage to research & development (R&D) operations was due to flood
RDWINDS !	Damage to R&D was due to high winds
RDBLDGQL !	Damage to R&D was due to building quality
RDOTHER 'n'	Damage to R&D was due to other factors
OTRFLOOD !	Damage to other operations was due to flood
OTRWIND !	Damage to other operations was due to high winds

Table 36—Continued

Variable Abbreviation	Variable
OTRBLDQL !	Damage to other operations was due to building quality
OTROTHER 'n'	Damage to other operations was due to other factors
Relocation Occurrence	
HQNOCONS	Did not consider relocating the HQ
HQCONSB 'n'	Considered relocating the HQ, but did not move
HQTEMPMV	Temporarily relocated HQ
HQPERM 'n'	Permanently relocated HQ
HQMWEEK	HQ was relocated (1 if 1-14 days; 2 if 15+ days)
LGNOCONS	Did not consider relocating the Logistics operations
LGCONSB !	Considered relocating logistics, but did not move
LGTEMPMV 'n'	Temporarily relocated logistics
LGPERM !	Permanently relocated logistics
DAYS LGMV 'n'	Duration (# days) the logistics was relocated
MFGNOCONS	Did not consider relocating the manufacturing operations
MFGCONSB !	Considered relocating the manufacturing, but did not move
MFGTMPMV 'n'	Temporarily relocated manufacturing
MFGPERM !	Permanently relocated manufacturing
DAYS MGMV 'n'	Duration (# days) the manufacturing was relocated
RDNOCONS 'n'	Did not consider relocating the R&D operations
RDCONSB !	Considered relocating the R&D, but did not move
RDTEMPMV !	Temporarily relocated R&D
RDPERM !	Permanently relocated R&D
RDDAYS !	Duration (# days) the R&D was relocated
OTRNOCNS 'n'	Did not consider relocating any other operations
OTRCONSB !	Considered relocating the other operations, but did not move
OTRTMPMV !	Temporarily relocated other operations
OTRPERM !	Permanently relocated other operations
OTR DAYS !	Duration (# days) the other operations was relocated
RELOCATE	Firm relocated some portion of its operations (HQ, logistics, manufacturing, R&D, other)
NOMVCONS	Firm did not consider moving any of its activities
Jurisdiction of New Location	
HQONSITE !	Moved HQ elsewhere onsite
HQSMJUR	Moved HQ elsewhere in the same government jurisdiction
HQNWJUR 'n'	Moved HQ to a location in a new government jurisdiction
LGONSITE !	Moved logistics elsewhere onsite
LGSMJUR 'n'	Moved logistics elsewhere in the same government jurisdiction
LGNWJUR !	Moved logistics to a location in a new government jurisdiction
MGONSITE !	Moved manufacturing elsewhere onsite
MFGSMJUR 'n'	Moved manufacturing elsewhere in the same government jurisdiction
MFGNWJUR !	Moved manufacturing to a location in a new government jurisdiction
RDONSITE !	Moved R&D elsewhere onsite
RDSMJUR !	Moved R&D elsewhere in the same government jurisdiction
RDNWJUR !	Moved R&D to a location in a new government jurisdiction
OTRONSIT !	Moved other operations elsewhere onsite
Variable Abbreviation	Variable
OTRSMJUR !	Moved other operations elsewhere in the same government jurisdiction
OTRNWJUR !	Moved other operations to a location in a new government jurisdiction

Table 36—Continued

Variable Abbreviation	Variable
Reasons Preventing Relocation	
NOMVRSN	No reason for relocating
SUNKCOST 'n'	Sunk costs prevented relocation
BUSTIES	Business ties prevented relocation
SOCTIES	Social ties prevented relocation
LOCALMKT 'n'	Local market prevented relocation
LCLMATRL 'n'	Local materials prevented relocation
NOLBRELS 'n'	Limitations of labor elsewhere prevented relocation
NOGDSITE	Lack of a suitable site prevented relocation
OTHER	Other reasons prevented relocation Elsewhere
LOCLECON	Local economic reasons prevent relocating (local market, local ties, sunk costs, & limited labor elsewhere)
NOLCLECN	Not local economic reasons preventing relocating (limitations of labor elsewhere and lack of a suitable site for relocating)
OTRRSN	Other reasons preventing relocating (social ties and "other")
Degree and Length of Disruption	
BLDGDEG	Degree of disruption to buildings (1-5 scale)
BLDGDAY	Number of days disruption due to building damage
EQPMTDEG	Degree of disruption to equipment (1-5 scale)
EQPMTDYS	Number of days disruption due to equipment damage
INVTYDEG	Degree of disruption to inventory (1-5 scale)
INVTYDYS	Number of days disruption due to inventory damage
RWMATDEG	Degree of disruption to raw materials (1-5 scale)
RWMATDYS	Number of days disruption due to raw materials damage
ASMINPDG	Degree of disruption to assembled inputs (1-5 scale)
ASMINPDY	Number of days disruption due to assembled inputs damage
MGMTDEG	Degree of disruption to unavailable management (1-5 scale)
MGMTDAYS	Number of days disruption due to unavailable management
STAFFDEG	Degree of disruption to unavailable staff (1-5 scale)
STAFFDYS	Number of days disruption due to unavailable staff
COMMSDEG	Degree of disruption to communications systems (1-5 scale)
COMMSDYS	Number of days disruption due to damaged communications
ELECDEG	Degree of disruption to electrical systems (1-5 scale)
ELECDAYS	Number of days disruption due to electrical systems damage
FINSVDEG	Disruption of access to financial services (1-5 scale)
FINSVDYS	Number of days disruption of access to financial services
ROADDEG	Degree of disruption due to damaged roads (1-5 scale)
ROADDAYS	Number of days disruption due to road damage
RAILDEG	Degree of disruption to buildings (1-5 scale)
RAILDAYS	Number of days disruption due to building damage
SHIPDEG	Degree of disruption to buildings (1-5 scale)
SHIPDAYS	Number of days disruption due to building damage
AIRDEG	Degree of disruption to buildings (1-5 scale)
AIRDAYS	Number of days disruption due to building damage
BLGDSV	Severity of disruption due to building damage (severe/extreme or not)
EQUIPSV	Severity of disruption due to equipment damage (severe/extreme or not)
INVTYYN	Severity of disruption due to inventory damage (yes/no)
RAWMATYN	Business disruption due to raw material damage (severe/extreme or not)
ASEMINYN	Business disruption due to assembled inputs damage (yes/no)

Table 36—Continued

Variable	Abbreviation	Variable
MGMTSV		Severity of disruption due to unavailable management (severe/extreme or not)
STAFFSV		Severity of disruption due to unavailable staff (severe/extreme or not)
COMMSV		Severity of disruption due to communications damage (severe/extreme or not)
ELECSV		Severity of disruption due to electricity damage (severe/extreme or not)
FINANYN		Business disruption due to unavailable financial services (yes/no)
ROADSV		Severity of disruption due to road damage (severe/extreme or not)
RAILYN		Business disruption due to rail damage (yes/no)
SHIPPLYN		Business disruption due to ship or air transport problems (yes/no)
Establishment Traits		
NAICS		North American Industry Classification System (4 digit)
SIC2DIG		North American Industry Classification System (2 digit)
BUSTYPE		Text description of NAICS code
CUR#EMPL		Current number of employees
FEWREMP		Fewer employees 6 months after Floyd
SAMEEMPL		Same number of employees 6 months after Floyd
MOREEMPL 'n'		More employees 6 months after Floyd
Independent		Independent firm
Franchise 'n'		Franchise
BRCHPLT		Branch plant
Subsidiary 'n'		Subsidiary
OTROPN 'n'		Other firm type
FIRMSIZE		Size of firm (small=<10 employees; medium=10-99; large=100+)
INDUSTRY		3 if manufacturer; 2 if wholesaler; all else 1
Site Traits		
OWN		Firm owns the site
LEASE		Firm leases the site
#Yrsgavl		Number of years in operation in Greenville
EXCLTEXP		Excellent site expansion potential
GOODEXP		Good site expansion potential
ADEQEXP		Adequate site expansion potential
POOREXP		Poor site expansion potential
UNSATEXP 'n'		Unsatisfactory site expansion potential
NTGDEXPN		Expansion potential of site is not good (2if poor or unsatisfactory; 1 if otherwise)
Operation Traits		
DECROPN		Decrease in operations
SAMEOPN		Same level of operations
INCROPN		Increase in operations
COMPTech *		Does firm use computer technology in its manufacturing
Market Traits		
Localmkt		Firm's primary market is local
OTRNCMKT		Firm's primary market is elsewhere in North Carolina
SEUSMKT		Firm's primary market is the southeastern US
NATLMKT		Firm's primary market is national
INTLMKT 'n'		Firm's primary market is international
NORGNMKT		Firm's primary market is national or international
Networking		
Hypotheses		
RESPINFL !		Respondent's influence of other firm's location decision
RESPINFL# !		Number of client's influenced by respondent's location decision

Table 36—Continued

Variable Abbreviation	Variable
NTWKINFL 'n'	Business client's influence of respondent's location decision
NTWKINFL# 'n'	Number of clients That influenced respondent's location decision
Disruption's Effect on Business Interaction	
CUSTBSBK	To what extent was business with major clients disrupted due to clients' business interruption (1-5 scale)
CUSTTPMV	To what extent was business with major clients disrupted due to clients' temporary relocation (1-5 scale)
CUSTPERM	To what Extent was business with major clients disrupted due to clients' permanent relocation (1-5 scale)
CUSTEND	To what Extent was business with major clients disrupted due to clients' termination of operations (1-5 scale)
CUSTOTR 'n'	To what Extent was business with major clients disrupted due to clients' other problems (1-5 scale)
RESPBSBK	To what Extent was business with major clients disrupted due to respondent's business interruption (1-5 scale)
RESPTPMV	To what Extent was business with major clients disrupted due to respondent's temporary relocation (1-5 scale)
RESPPERM	To what Extent was business with major clients disrupted due to respondent's permanent relocation (1-5 scale)
RESPOTR 'n'	To what Extent was business with major clients disrupted due to respondent's other problems (1-5 scale)
CLBRKYN	Business interruption due to major client's own business interruption (yes/no)
CLTMPYN	Business interruption due to major client's temporary relocation of own Business (yes/no)
CLPERMYN	Business interruption due to major client's own permanent relocation of own business (yes/no)
CLENDYN	Business interruption due to closure of major client's business (yes/no)
SVRSPBRK	Severity of loss of business interaction with major clients due to respondent's own business interruption (severe/extreme or not)
RSPTMPYN	Disruption of business with major clients due to respondent's temporary relocation of own business (yes/no)
SVRSPERM	Severity of loss of business interaction with major clients due to respondent's permanent relocation of own business (severe/extreme or not)
Change in Client Base	
#CUSTDCR	Number of customers lost due to Floyd
#CUSTINC	Number of customers gained due to Floyd
CUSTGAIN	Respondent reported gaining customers after Floyd
CUSTLOST	Respondent reported losing customers after Floyd
Assistance Traits	
OKNOBANK	Able to absorb cost of disruption/damage without commercial loans (yes/no)
NGOASK !	Requested assistance from an NGO (yes/no)
ASSOCASK !	Requested assistance from a business association (yes/no)
CITYASK !	Requested assistance from the city government (yes/no)
STATEASK 'n'	Requested assistance from the state government (yes/no)
FEDASK	Requested assistance from the federal government (yes/no)
INTLASK !	Requested assistance from an international government (yes/no)
NGORECD !	Received assistance from an NGO (yes/no)

Table 36—Continued

Variable Abbreviation	Variable
ASSOCD	Received assistance from a business association (yes/no)
CITYRECD	Received assistance from the city government (yes/no)
STRECD 'n'	Received assistance from the state government (yes/no)
FEDRECD	Received assistance from the federal government (yes/no)
INTLRECD	Received assistance from an international government (yes/no)
FINAIDGD	Financial aid received was helpful (yes/no)
GVTINFL	Assistance from the government influenced the firm's Location (yes/no)
Respondent's Priorities for Restoring Operations	(for each item in the section below: 1=first priority; 2=second; 3=third)
EMPLOYES	Importance of getting staff & mgmt back to worksite (yes/no)
RDACCESS	Getting roads repaired or cleared of floodwaters/debris (yes/no)
COMMS	Getting communications systems restored (phones, Internet, fax, forwarding shipments of goods) (yes/no)
ELECTRCY	Getting electrical service restored (yes/no)
FACACSS	Getting access to the facility (via boat, or after floodwaters recede) (yes/no)
RENOVATN 'n'	Getting facility renovated/repaired (yes/no)
INSURNC 'n'	Facilitating payment of insurance settlements (yes/no)
OTRMGMT	Other management issues (employee survival issues, morale, safety, salvage operations, equipment needs) (yes/no)
FACISSUE	If firm representative mentioned problems with the facility (communications, electricity, facility access—but not roads—renovation, or insurance) as either the first, second, or third priority
PRIEMPL	If firm representative mentioned the importance of getting employees to work as either the first, second, or third priority
PRIRDACC	If firm representative mentioned the getting access to the facility as either the first, second, or third priority
PRIMGMT	If firm representative mentioned various management issues (employee survival issues, morale, safety, salvage operations, equipment needs) as either the first, second, or third priority
Interview Variables	
FLOODDMG	Level of flooding at site indicated during interview (1-5 scale)
YNFLDDMG	Damage to equipment or structure due to flooding on site indicated during interview (yes/no)
Levels of Management	
OWNER	Establishment's level of mgmt is owner/general manager (1 level of mgmt; only one decision-maker present)
FOREMEN	Establishment's level of mgmt is intermediate (owner/general manager is decision-maker, junior manager is supervisor of staff)
DIRECTRS	Establishment's level of mgmt is advanced (3 or more levels, with decision-making authority below owner/general Manager level)

APPENDIX D

Recoded Variables

Variables are listed in their order of appearance in the survey instrument, by section. Variables listed in *italics* are those recoded from other variables. Recoded variables are in the same section as the original variables used in the recoding process.

Table 37—Survey Variables

New Variable	Criteria for Recoding
Disaster Variables	
SEVINTPN	Overall Degree of Severity of Business Interruption 2 if Severe or Extreme; 1 if otherwise
Relocation Occurrence	
RELOCATE	Firm Relocated Some Portion of its Operations (HQ, Logistics, Manuf., R&D) 2 if yes; 1 if no
NOMVCONS	Firm Did Not Consider Moving Any of its Activities 2 if yes; 1 if no
HQNOCONS	Did Not Consider Relocating the HQ 2 if yes; 1 if no
Reasons Preventing Relocation	
LOCLECON	Local Economic Reasons Prevent Relocating 2 if yes to any of the following variables: Sunk Costs, Local Market, & Local Material; 1 if otherwise
NOLCLECN	Not Local Economic Reasons Preventing Relocating 2 if yes to any of the following variables: Limitations of Labor Elsewhere and Lack of a Suitable Site for Relocating; 1 if otherwise
OTRRSN	Other Reasons Preventing Relocating 2 if yes to any of the following variables: Social Ties and "Other"; 1 if otherwise
Degree and Length of Disruption	
BLDGSV	Severity of Disruption due to Building Damage 2 if Severe or Extreme; 1 if otherwise
EQUIPSV	Severity of Disruption due to Equipment Damage 2 if Severe or Extreme; 1 if otherwise
INVNTYYN	Severity of Disruption due to Inventory Damage (Yes/No)
RAWMATYN	Business Disruption due to Raw Material Damage (Severe/Extreme or not)
ASEMINYN	Business Disruption due to Assembled Inputs Damage (Yes/No)
MGMTSV	Severity of Disruption due to Unavailable Management (Severe/Extreme or not)
STAFFSV	Severity of Disruption due to Unavailable Staff (Severe/Extreme or not)
FINANYN	Business Disruption due to Unavailable Financial Services (Yes/No)
ROADSV	Severity of Disruption due to Road Damage (Severe/Extreme or not)
RAILYN	Business Disruption due to Rail Damage (Yes/No)
SHIPPLYN	Business Disruption due to Ship or Air Transport Problems (Yes/No)

Table 37—Continued

New Variable	Criteria for Recoding
COMMSV	Severity of Disruption due to Communications Damage (Severe/Extreme or not)
ELECSV	Severity of Disruption due to Electricity Damage (Severe/Extreme or not)
Establishment Traits	
INDUSTRY	3 if Manufacturer; 2 if Wholesaler; all else 1
FIRMSIZE	Size of Firm 1 if <10 empl; 2 if 10-99 empl; 3 if 100+ empl
Site Traits	
NTGDEXPN	Expansion Potential of Site 2 if Poor or Unsatisfactory; 1 if otherwise
Market Traits	
NORGNMKT	Firm's Primary Market is National or International 2 if yes; 1 if no
Disruption's Effect on Business Interaction	
CLBRKYN	Business Interruption due to Major Client's Own Business Interruption (Yes/No)
CLTMPYN	Business Interruption due to Major Client's Temporary Relocation of Own Business (Yes/No)
CLPERMYN	Business Interruption due to Major Client's Own Permanent Relocation of Own Business (Yes/No)
CLENDYN	Business Interruption due to Closure of Major Client's Business (Yes/No)
SVRSPBRK	Severity of Loss of Business Interaction with Major Clients due to Respondent's Own Business Interruption (Severe/Extreme or not)
RSPTMPYN	Disruption of Business with Major Clients due to Respondent's Temporary Relocation of Own Business (Yes/No)
SVRSPERM	Severity of Loss of Business Interaction with Major Clients due to Respondent's Permanent Relocation of Own Business (Severe/Extreme or not)
Change in Client Base	
CUSTGAIN	Respondent Reported Gaining Customers after Flood 2 if yes; 1 if no
CUSTLOST	Respondent Reported Losing Customers after Flood 2 if yes; 1 if no
Survey Priorities for Restoring Operations	
FACISSUE	Problems with the Facility 2 if yes to any of the following variables: Communications, Electricity, Facility Access (not road access) Renovation, or Insurance; 1 if otherwise
PRIEMPL	If Firm Representative Mentioned the Importance of Getting Employees to Work as Either the First, Second, or Third Priority
PRIRDACC	If Firm Representative Mentioned the Getting Access to the Facility as Either the First, Second, or Third Priority
PRIMGMT	If Firm Representative Mentioned Various Management Issues (Employee Survival Issues, Morale, Safety, Salvage Operations, Equipment Needs, etc.) as Either the First, Second, or Third Priority
Interview Variables	
YNFLDDMG	Damage to Equipment or Structure due to Flooding on Site Indicated During Interview (Yes/No)

APPENDIX E

VARIABLES NOT USED IN THE ANALYSIS

Variables are listed in their order of appearance in the survey instrument, by survey section. Variables followed by (n=) had fewer than 5 responses. Variables followed by an asterisk (*) were not used due to problems with the survey question. Variables followed by an exclamation point (!) had zero responses. Some of these variables could not be combined into a new variable because once the variables are recoded the sum is still less than five. An example is FRANCHISE, SUBSIDIARY and OTROPN. Additionally, in some combinations of variables, after duplicate responses from the same participant are removed, there are still fewer than five responses. This occurs with HQNWJUR, LGSMJUR, and MFGSMJUR, because the same respondent was the only one to reply to select these responses.

Table 37—Variables Not Used in the Analysis

Variable Abbreviation	Variable
Disaster Variables	
FLOODS (n=2)	Number of Floods Experienced
High Wind (n=2)	Number of High Wind Events (e.g. tornadoes) Experienced
Otr Climate (n=2)	Number of Other Climate Events (Hail storms, Snow storms) Experienced
DIST2HAZ *	Distance to the Nearest Natural Hazard (e.g., river) in Miles
Source of Damage	
HQWINDS (n=2)	Damage to HQ was due to High Winds
HQBLDGQL !	Damage to HQ was due to Building Quality
HQOTHER (n=4)	Damage to HQ was due to Other Factors
LGWINDS (n=1)	Damage to Logistics Operations was due to High Winds
LGBLDGQL (n=1)	Damage to Logistics Operations was due to Building Quality
LGOTHER (n=2)	Damage to Logistics Operations was due to Other Factors
MFGWINDS !	Damage to Manufacturing Operations was due to High Winds
MFGBLDQL !	Damage to Manufacturing Operations was due to Building Quality
MFGOTHER (n=3)	Damage to Manufacturing Operations was due to Other Factors
RDFLOODS (n=2)	Damage to Research & Development (R&D) Operations was due to Flood
RDWINDS !	Damage to R&D was due to High Winds
RDBLDGQL !	Damage to R&D was due to Building Quality
RDOTHER (n=1)	Damage to R&D was due to Other Factors
OTRFLOOD !	Damage to Other Operations was due to Flood
OTRWIND !	Damage to Other Operations was due to High Winds
OTRBLDQL !	Damage to Other Operations was due to Building Quality
OTROTHER (n=1)	Damage to Other Operations was due to Other Factors
Relocation Occurrence	
HQPERM (n=1)	Permanently Relocated HQ
LGCONSB !	Considered Relocating the Logistics, But Did Not Move
LGTEMPMV (n=3)	Temporarily Relocated Logistics
LGPERM !	Permanently Relocated Logistics

Table 37—Continued

Variable Abbreviation	Variable
DAYS LGMV (n=3)	Duration (Number of Days) the Logistics was Relocated
MFG CONSB !	Considered Relocating the Manufacturing, But Did Not Move
MFG TMPMV (n=1)	Temporarily Relocated Manufacturing
MFG PERM !	Permanently Relocated Manufacturing
DAYS M GMV (n=2)	Duration (Number of Days) the Manufacturing was Relocated
RDN OCONS (n=4)	Did Not Consider Relocating the R&D Operations
RDN CONSB !	Considered Relocating the R&D, But Did Not Move
RDT EPMV !	Temporarily Relocated R&D
RDT PERM !	Permanently Relocated R&D
RDDAYS !	Duration (Number of Days) the R&D was Relocated
OTR NOCNS (n=1)	Did Not Consider Relocating Any Other Operations
OTR CONSB !	Considered Relocating the Other Operations, But Did Not Move
OTR TMPMV !	Temporarily Relocated Other Operations
OTR PERM !	Permanently Relocated Other Operations
OTR DAYS !	Duration (Number of Days) the Other Operations was Relocated
Jurisdiction of New Location	
HQONSITE !	Moved HQ Elsewhere Onsite
HQNWJUR (n=1)	Moved HQ to a Location in a New Government Jurisdiction
LGONSITE !	Moved Logistics Elsewhere Onsite
LGSMJUR (n=1)	Moved Logistics Elsewhere in the Same Government Jurisdiction
LGNWJUR !	Moved Logistics to a Location in a New Government Jurisdiction
MGONSITE !	Moved manufacturing Elsewhere Onsite
MFGSMJUR (n=1)	Moved Manufacturing Elsewhere in the Same Government Jurisdiction
MFGNWJUR !	Moved Manufacturing to a Location in a New Government Jurisdiction
RDONSITE !	Moved R&D Elsewhere Onsite
RDSMJUR !	Moved R&D Elsewhere in the Same Government Jurisdiction
RDNWJUR !	Moved R&D to a Location in a New Government Jurisdiction
OTRONSIT !	Moved Other Operations Elsewhere Onsite
OTRSMJUR !	Moved Other Operations Elsewhere in the Same Government Jurisdiction
OTRNWJUR !	Moved Other Operations to a Location in a New Government Jurisdiction
Establishment Traits	
Franchise (n=1)	Franchise
Subsidiary (n=1)	Subsidiary
OTROPN (n=2)	Other Firm Type
Operation Traits	
COMPTech *	Does Firm Use Computer Technology in its Manufacturing
Networking Hypotheses	
RESPINFL !	Respondent's Influence of Other Firm's Location Decision
RESPINFL# !	Number of Client's Influenced by Respondent's Location Decision
NTWKINFL (n=4)	Business Client's Influence of Respondent's Location Decision
NTWKINFL# (n=3)	Number of Clients That Influenced Respondent's Location Decision
Disruption's Effect on Business Interaction	
CUSTOTR (n=2)	To What Extent was Business with Major Clients Disrupted Due to Clients' Other Problems (1-5 scale)
RESPOTR (n=4)	To What Extent was Business with Major Clients Disrupted Due to Respondent's Other Problems (1-5 scale)
Assistance Traits	
NGOASK !	Requested Assistance from an NGO

Table 37—Continued

Variable Abbreviation	Variable
ASSOCASK !	Requested Assistance from a Business Association
CITYASK !	Requested Assistance from the City Government
STATEASK (n=2)	Requested Assistance from the State Government
INTLASK !	Requested Assistance from an International Government
NGORECD !	Received Assistance from an NGO
ASSOCRCD !	Received Assistance from a Business Association
CITYRECD !	Received Assistance from the City Government
STRECD (n=2)	Received Assistance from the State Government
INTLRECD !	Received Assistance from an International Government

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BIOGRAPHICAL SKETCH

Ann Angelheart was born to be a geographer. What started out as a family tradition of Sunday drives and summer camping trips led to her travels across Western Europe, the South Pacific, and this remarkable country. She has traveled so much that the highways, byways, and flyways of this lovely world are her home. Her concern regarding the recovery of communities from the effects of a natural disaster led to her return to the University of Florida for her Ph.D. She hopes to continue conducting research in this area, and to serve as an educator of the bright minds on college campuses.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



Edward J. Malecki, Chairman
Professor of Geography

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Professor of Geography

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